# MAINTENANCE MANUAL

Manual No.: DLA-50T-MM1

Issued: January 1994

Pages 1-54

## DLA-50T SYSTEM

SOLID STATE REFRIGERATOR
BIOMEDICAL, DRUGS AND WHOLE BLOOD

REFRIGERATOR DLA-50T PN A-2244-2

POWER SUPPLY PS-50B PN-A-2160-3

RECORDER DTR-50-10 PN A-2224-2

**NSN 4110-01-287-7111**
**NATO 4310-99-770-7126**

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**THERMOPOL INC.**
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## Section 1
## DLA-50T Description and Operation

### 1-0. Unpacking the DLA-50T

1. Inspect shipping box immediately for evidence of damage.
2. Stand the carton upright. (Note arrows)
3. Cut the plastic packing bands.
4. Pull up all top cover's flaps of shipping container.
5. Pulling from the top, lift the DLA-50T out of shipping box.
6. Open unit, and remove all inside contents.
7. Verify contents to include:
   - 1 - Power Supply (PS-50B)
   - 2 - Maintenance Manuals (DLA-50T-MM1)
   - 2 - Operational Manuals (DLA-50T-OP1)
   - 1 - Wire Basket (WB-30B)
   - 1 - DC Power Cable (PC-30B)
   - 1 - Temperature Recorder (DTR-50-10)
8. Inspect contents immediately for damage.

If the unit or contents are defective or damaged, contact factory within 24 hours.

**Phone (708) 595-1110**
**Fax (708) 595-3123**

or notify in writing to:

**Thermopol Inc.**
**2468 Delta Lane**
**Elk Grove Village, IL 60007**

## 1-1. General

The DLA-50T is a solid state refrigerator/heater unit designed to keep the contents of the load compartment at the blood storage temperature, over the operational ambient range.

The unit has no moving parts, and does not require fans, motors, gas or air pressure. Cooling is performed by thermoelectric technology.

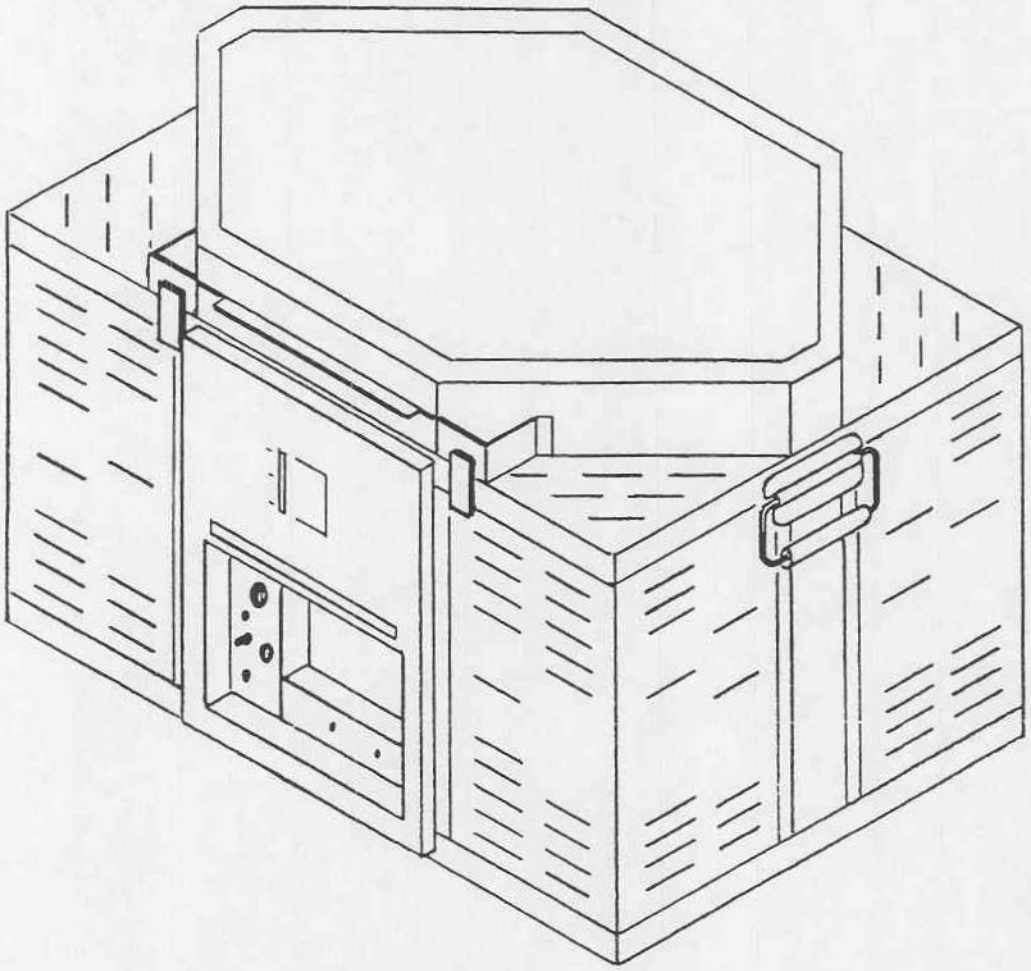


**Figure 1**
**DLA-50T Blood Storage and Transportation Refrigerator**

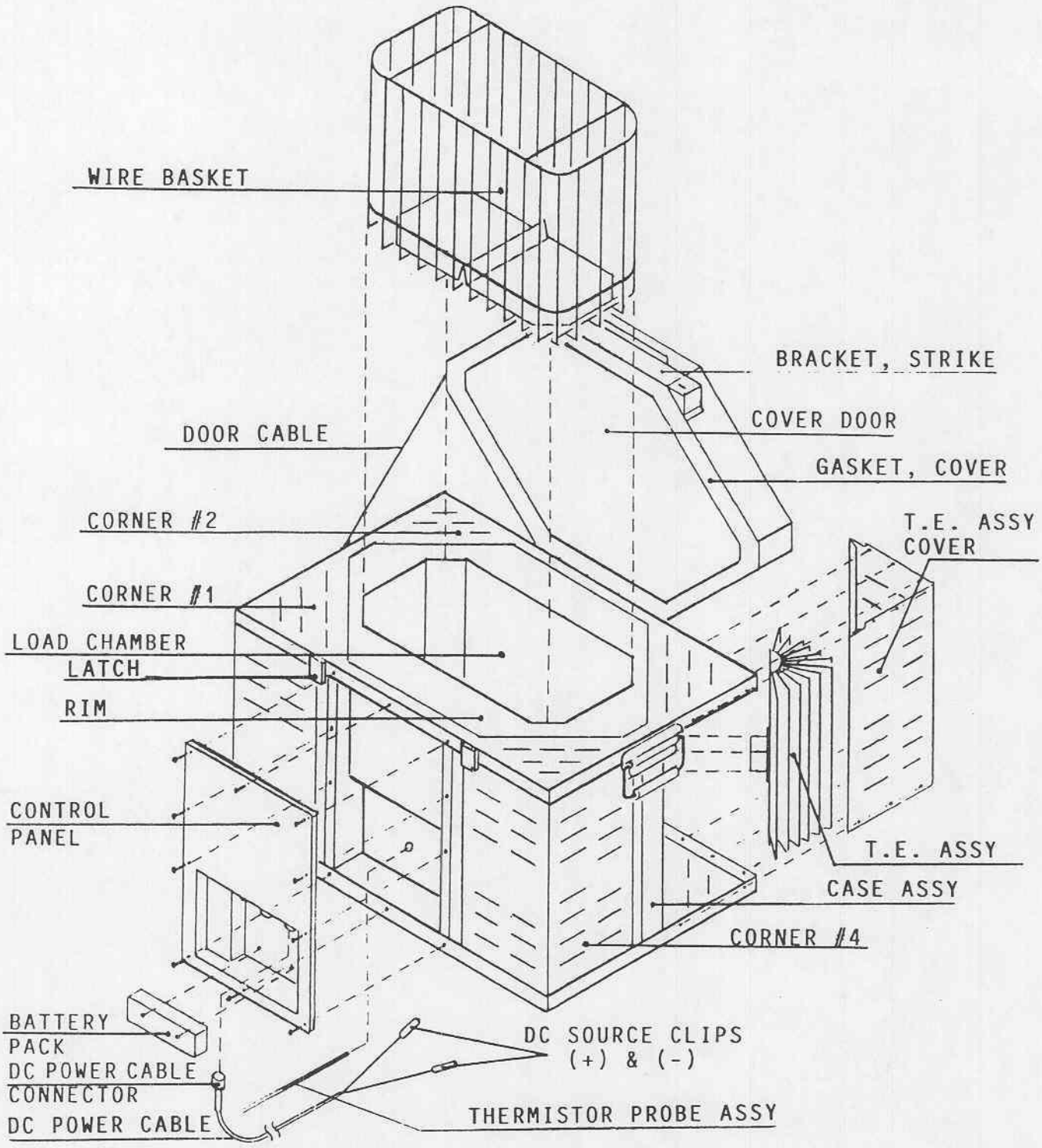



**Figure 2**
**DLA-50T Exploded Front View**

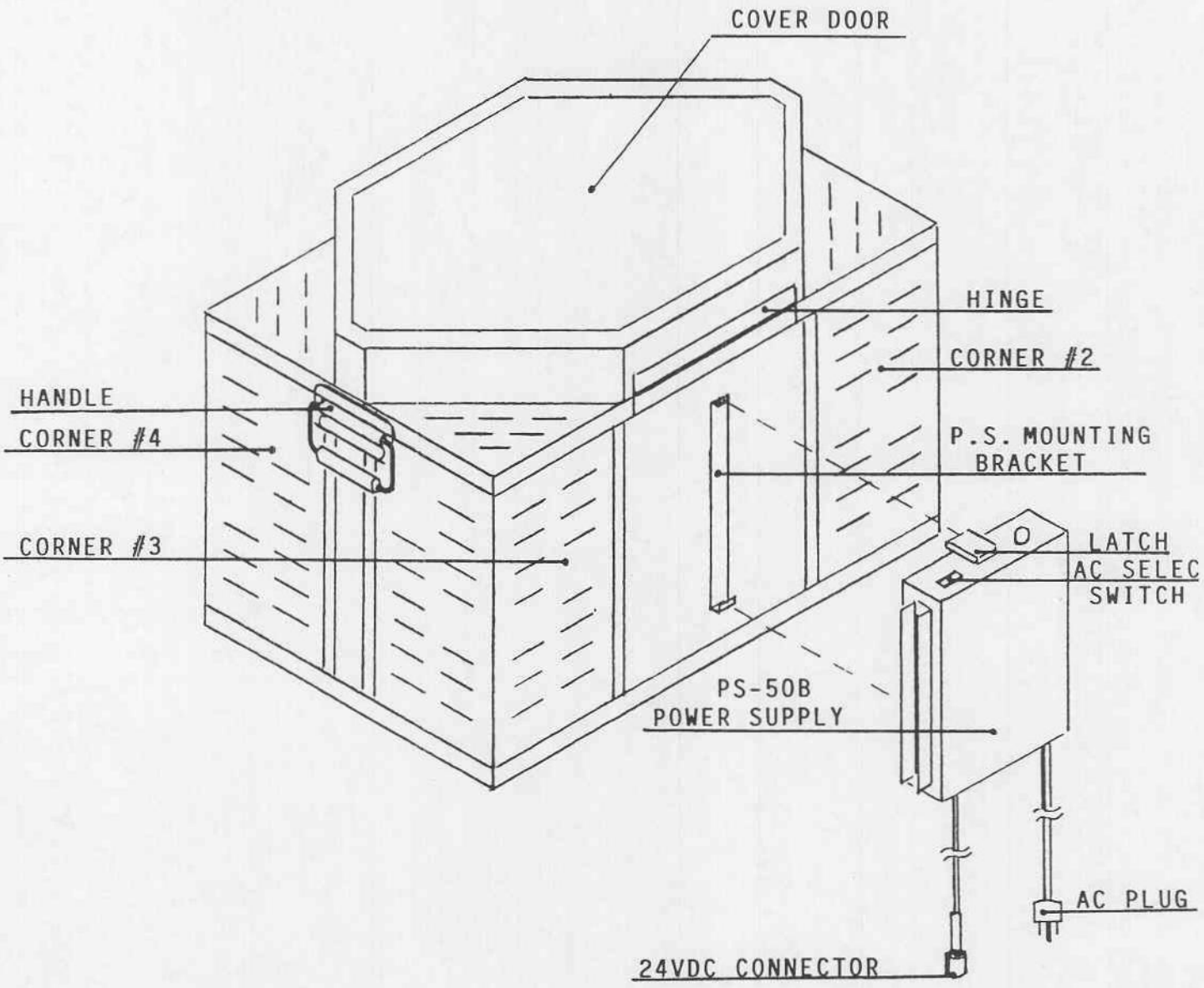



**Figure 3**
**DLA-50T Exploded Rear View**

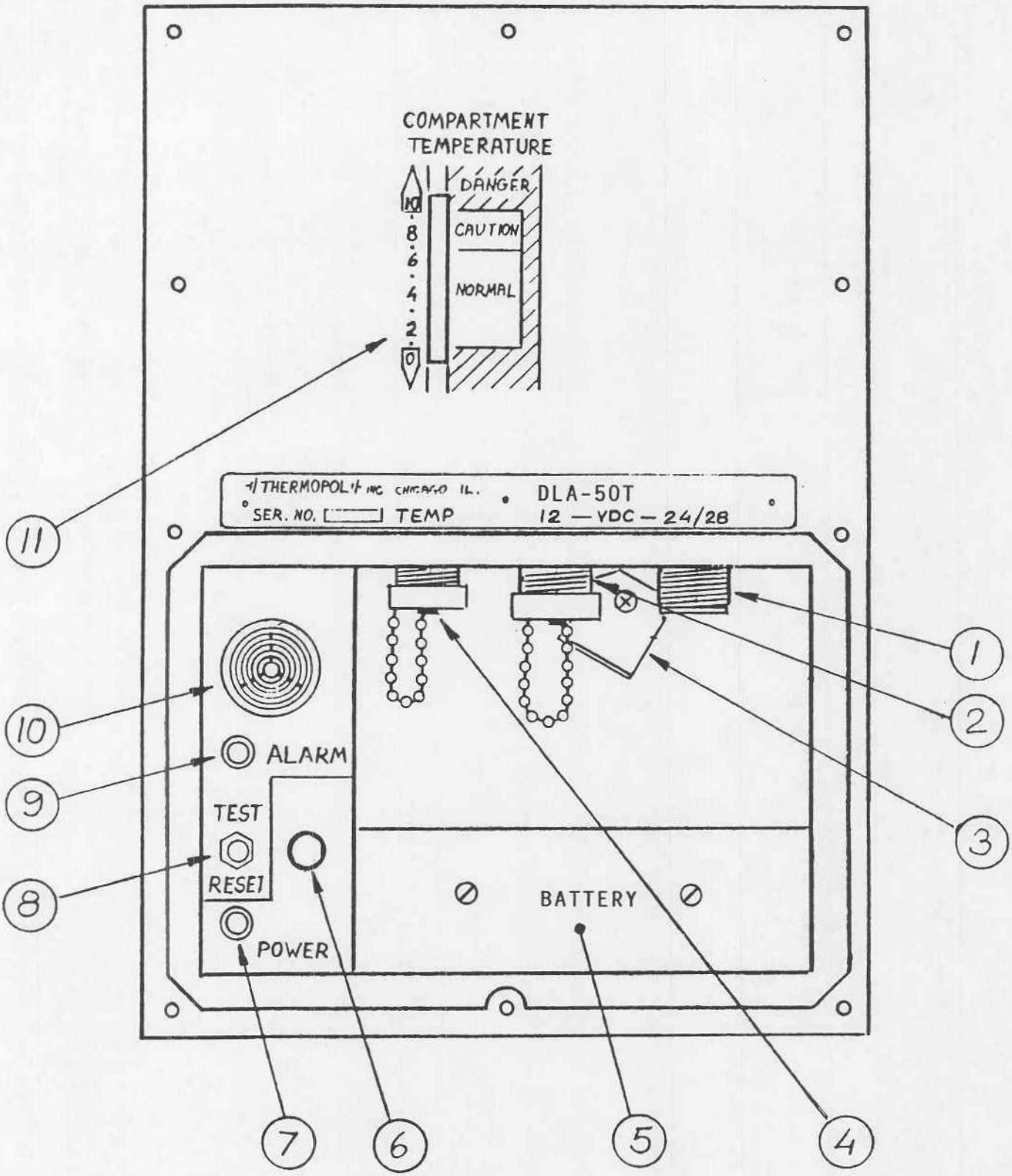



**Figure 4**
**DLA-50T Control Panel**

DLA-50T Control Panel Function Description

| Item | Function/Description |
|---|---|
| 1 | **24/28VDC POWER RECEPTACLE.** Connects a 24/28VDC power source through Power Cable PC-50 (PN A-2089). Alternatively, connects Power Supply PS-50B (PN A-2160-3). |
| 2 | **12VDC POWER RECEPTACLE.** Connects a 12VDC power source through Power Cable PC-50 (PN A-2089). |
| 3 | **INTERLOCK.** Prevents plugging in two connectors at the same time. |
| 4 | **TEMPERATURE RECEPTACLE.** Used for optional remote thermometer or recorder. |
| 5 | **BATTERY PACK.** Standby power for thermometer and alarm during power failure. (Continuously recharging). |
| 6 | **CIRCUIT BREAKER.** Provides overcurrent protection, push to reset. |
| 7 | **POWER INDICATOR.** Lights green when unit is properly powered. |
| 8 | **ALARM TEST/RESET SWITCH.** Push up for testing, push down for resetting. |
| 9 | **VISUAL ALARM SIGNAL.** Blinks red when alarm is activated. |
| 10 | **AUDIO ALARM SIGNAL.** Beeps when alarm is activated. |
| 11 | **THERMOMETER.** Color coded display of compartment temperature. Red for DANGER ZONE 32° F (0° C) and below; 50° F (10° C) and above. |

## 1-2. Description and Specifications

The unit is a modified commercial blood and vaccine transportation unit designed for operation in military environments.

The DLA-50T operates on 12VDC or 24-28VDC and can be plugged into a 120VAC or 220VAC main, through a rectifier Power Supply PS-50B. The PS-50B can be mounted on the unit. The DLA-50T inner capacity is approximately 1 cubic foot and can accommodate 37 X 450ml blood bags.

## DLA-50T SPECIFICATIONS

Electrical Specifications for the DLA-50T are listed below:

| Voltage | Current |
|---|---|
| 12VDC Nominal | 7 Amps Max. |
| 24/28VDC Nominal | 4.5 Amps Max. |
| 120VAC, 50Hz | 1.6 Amps Max. |
| 120VAC, 60Hz | 1.6 Amps Max. |
| 220VAC, 50Hz | 0.8 Amps Max. |
| 220VAC, 60Hz | 0.8 Amps Max. |

Physical Dimensions

| | Outside | Inside |
|---|---|---|
| Width | 26in/66cm | 16.9in/43cm |
| Depth | 19.3in/48.9cm | 8.5in/21.6cm |
| Height | 18.5in/47cm | 11.8in/30cm |
| Volume | 5.4 Cu. Ft/0.15 Cu. M | 1 Cu. Ft./28 Liter |
| Weight | 68 lbs/31 Kg | |

### 1-3. Functional Description of the System

The Block Diagram as shown (Page 15 Figure 5), describes the functions of the components and their interrelationships, required for the operation of the DLA-50T Solid State Refrigerator System.

The purpose of the DLA-50T unit is to maintain a constant, preset COMPARTMENT temperature of 33.8° F (1° C) to 42.8° F (6° C) for blood transportation and storage needs.

The DLA-50T utilizes a solid state thermoelectric effect, in its HEAT PUMPING SYSTEM. At high ambient temperatures, heat is pumped out of the COMPARTMENT thereby cooling it. At low ambient temperatures, heating is achieved by reversing the pumped heat direction. The heat flow direction is controlled by the current direction in the solid state HEAT PUMPING SYSTEM (module) to keep the COMPARTMENT temperature constant. The TEMPERATURE CONTROL automatically determines the duty cycle and direction of the heat pumped.

SENSOR T1 reacts to the COMPARTMENT temperature. It continuously provides the command signal to the TEMPERATURE CONTROL.

The POWER INPUT SECTION provides the DLA-50T with the power source voltage, by plugging the POWER CABLE of either the AC, via the PS-50B Power Supply, or a DC source into the appropriate receptacle in the Front Panel, (Page 10 Figure 4). This section also provides the resettable overcurrent and reverse polarity protection.

The DLA-50T ALARM system and THERMOMETER are powered by an independent BATTERY PACK to safeguard the temperature integrity of the COMPARTMENT temperature. The THERMOMETER measures and displays the COMPARTMENT temperature. The input signal is fed from SENSOR T2 which senses the temperature inside the load COMPARTMENT.

An audio-visual ALARM is triggered when the temperature inside the COMPARTMENT falls outside the acceptable range of 35.6° F (2° C) to 42.8° F (6° C). The alarm is manually resettable.

The ALARM system and the THERMOMETER are powered by a continuously recharging BATTERY PACK, for standby operation during a power failure

SENSOR T3 provides an output signal for an optional remote thermometer or recorder.

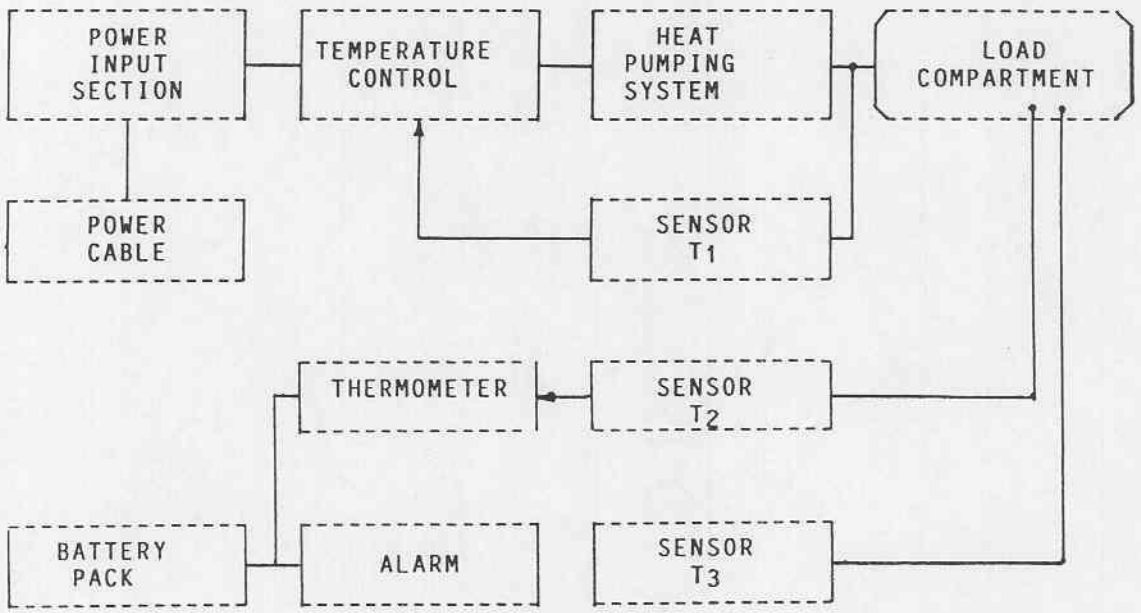



**Figure 5**
**DLA-50T Block Diagram**

### 1-4. Heat Pumping System

The DLA-50T utilizes the thermoelectric effect as its heat pumping device. When electric current passes through a junction of two dissimilar conductors, a thermocouple heat is absorbed and a cooling effect is produced at the junction.

The thermoelectric cooling couples (Page 16 Figure 6) are made of two elements of semiconductor material, primarily Bismuth Telluride, heavily doped to create an excess (N Type) or deficiency (P Type) of electrons. Heat absorbed at the cold junction, is pumped to the hot junction at a rate proportional to carrier current passing through the circuit, and the number of couples. Couples are connected in series electrically and in parallel thermally to form a Thermoelectric Module. The direction of the current flow dictates the heating mode of the load compartment under low temperature environmental conditions.

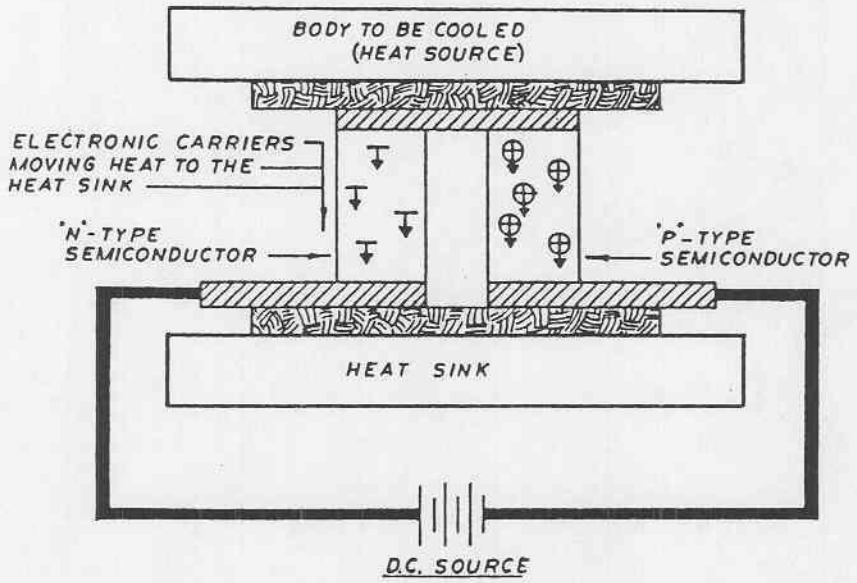



**Figure 6**
**Thermoelectric Cooling/Heating Couple**

### 1-5. Temperature Control, Thermometer and Alarm Systems

The Control Board CAT-024 Figure 7, provides the (A) temperature control, (B) thermometer and (C) alarm functions for the DLA-50T. Component placement is on Page 18 Figure 8. The board is mounted on the inside of the Control Panel. The board contains 3 sections as follows:

(A) Temperature Control Section D-2204 Page 23 Fig. 10

(B) Thermometer Section D-2202 Page 25 Fig. 11

(C) Alarm Section D-2203 Page 29 Fig. 12

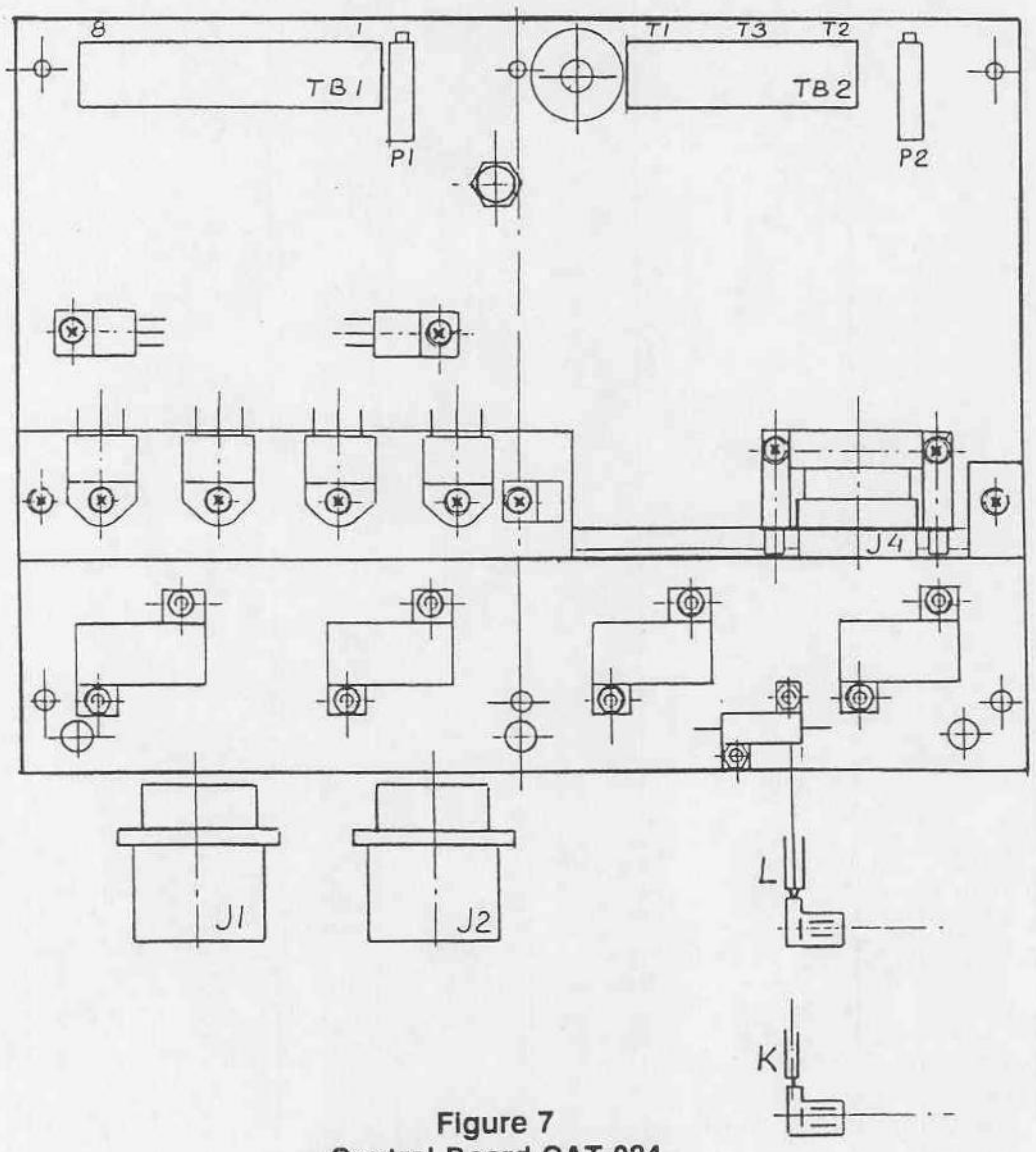
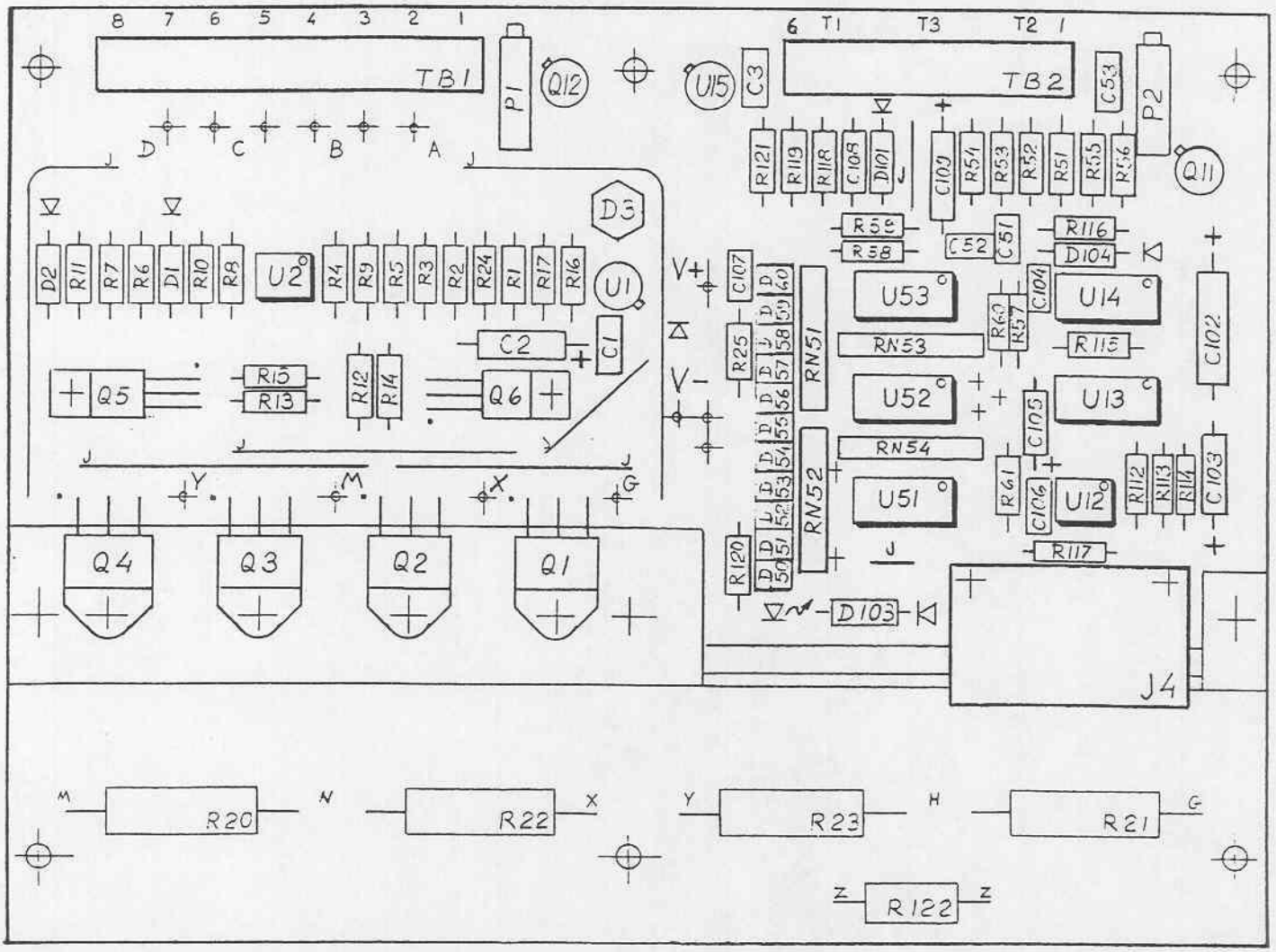



**Figure 7**
**Control Board CAT-024**




NOTE: D50 THRU D60 ARE MOUNTED ON THE CONDUCTOR SIDE

**C - CAPACITOR**
**D - DIODE**
**P - POTENTIOMETER**
**Q - TRANSISTOR**
**R - RESISTOR**
**RN - RESISTOR NETWORK**
**TB - TERMINAL BOARD**
**U - INTEGRATED CIRCUIT**

**Figure 8**
**Component Placement CAT-024**

## 1-6. Electronic Parts List, CAT-024

| | | | | |
|---|---|---|---|---|
| R1,R3,R51,R52,R53 | RES | 30.1K | 1% | 1/4W |
| R2 | RES | 221 | 1% | 1/4W |
| R4,R5,R6,R7,R54,R55 | RES | 100K | 5% | 1/4W |
| R8,R9 | RES | 10M | 5% | 1/4W |
| R10,R11,R116,R117 | RES | 1K | 5% | 1/4W |
| R12,R13 | RES | 22K | 5% | 1/4W |
| R14,R15 | RES | 4.7K | 5% | 1/4W |
| R16 | RES | 270 | 5% | 1/4W |
| R17 | RES | 1620 | 1% | 1/4W |
| R20,R21 | RES | 40 | 1% | 25W |
| R22,R23 | RES | 12 | 1% | 25W |
| R24 | RES | 22.1 | 1% | 1/4W |
| R25 | RES | 2.2K | 5% | 1/4W |
| R56,R57 | RES | 680K | 1% | 1/4W |
| R58,R113 | RES | 470K | 5% | 1/4W |
| R59 | RES | 470 | 5% | 1/4W |
| R60,R61 | RES | 5.6M | 5% | 1/4W |
| R112 | RES | 10K | 5% | 1/4W |
| R114 | RES | 82K | 5% | 1/4W |
| R115 | RES | 8.2K | 5% | 1/4W |
| R118 | RES | 243 | 1% | 1/4W |
| R119 | RES | 1.5K | 1% | 1/4W |
| R120 | RES | 11.5 | 5% | 1/4W |
| R121 | RES | 100 | 5% | 1/4W |
| | | 10 | 1% | 5W |
| RN51,RN52 | RES | 5X470K | 2% | 1/4W |
| RN53,RN54 | RES | 5X100K | 2% | 1/4W |
| C1 | CAP | 47K pF | 10% | 50V |
| C2 | CAP | 6.8MF | 20% | 35WVDC |
| C3,C53 | CAP | 12K pF | 10% | 50V |
| C51,C52,C104,C106,C107 | CAP | 0.1MF | 10% | 50V |
| C102 | CAP | 47MF | 20% | 20WVDC |
| C103 | CAP | 10MF | 20% | 20WVDC |
| C105,C108 | CAP | 1.2MF | 20% | 20WVDC |
| C109 | CAP | 22MF | 20% | 15WVDC |
| P1 | POT | 10K | 10% | 0.75W |
| P2 | POT | 5K | 10% | 0.75W |

**NOTE: Resistance - Ohms.**
**% Tolerances - Plus, Minus.**

**CONTINUED**

| | | |
|---|---|---|
| Q1,Q3 | TIP 36B | PNP POWER TRANSISTOR |
| Q2,Q4 | TIP 35B | NPN POWER TRANSISTOR |
| Q5,Q6 | TIP 121 | NPN POWER TRANSISTOR |
| Q11,Q12 | 2N2219 | NPN POWER TRANSISTOR |
| U1,U15 | LM 117 H | VOLTAGE REGULATOR |
| U2 | LM 158 J | DUAL OPERATIONAL AMPLIFIER |
| U12 | LM555 | TIMER |
| U13,U14 | MC 14001 BAL | QUAD 2 INPUT NOR GATE |
| U51,U52,U53 | LM 124 J | QUAD OPERATIONAL AMPLIFIER |
| D1,D2,D104 | IN 4148 | DIODE |
| D3 | MBR3545 | SCHOTTKY RECTIFIER |
| D101,D103 | IN4001 | DIODE |
| D50,D60 | LED RED MV57123 | LED LAMP RED |
| D53,D54,D55 | LED GRN MV54123 | LED LAMP GREEN |
| D51,D52,D56,D57,D58,D59 | LED YEL MV53123 | LED LAMP YELLOW |
| T1,T2 | NTC 10K | NEG TEMP COEF THERMISTOR |
| T3 | NTC 3K | NEG TEMP COEF THERMISTOR |
| J1,J2 | CONNECTOR | |
| | MS-3102A-18-01P | BOX MOUNTING RECEPTACLE |
| J4 | CONNECTOR | |
| | AMP-205868-1 | RECEPTACLE |

**Control Board CAT-024 - Temperature Control Section**

Page 23 Figure 10 Circuit Description D-2204

The Thermistor T1 senses the temperature at the control point. A change of temperature at T1 causes a change of its resistance and a corresponding voltage change at point III of the sensing bridge. The sensing bridge also consists of R1 and R3 with values close to the set point of T1, and P1 with R24 for the purpose of adjusting the set point. For adjustment procedure, see Page 39 Section 4-3 Para. 11.

The bridge voltages are applied to the bipolar op-amps U2 serving as voltage comparators. When the voltage III is higher than voltage II, the system will operate in the Heat Mode. When the voltage III is lower than voltage I, the system will operate in the Cool Mode. The gap between the two modes is determined by R2, and is directly proportional to the value of the resistor.

The following figure shows the control performance of the Temperature Control Section:

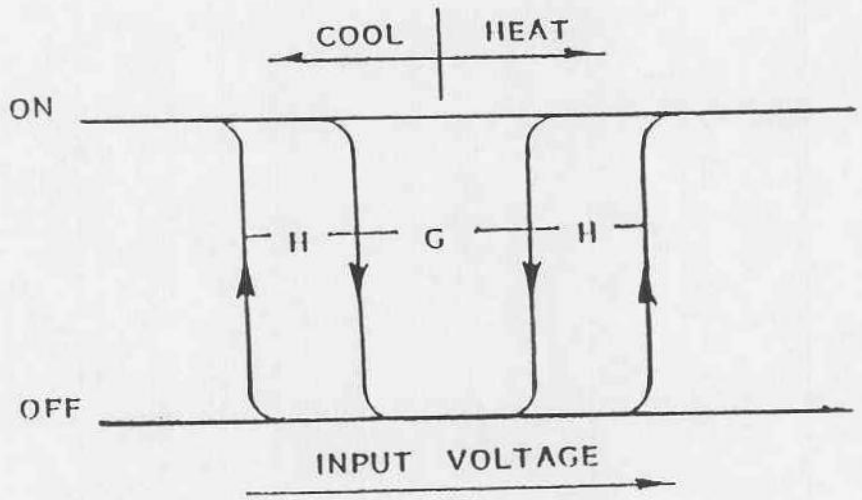



**Figure 9**
**Control Performance**

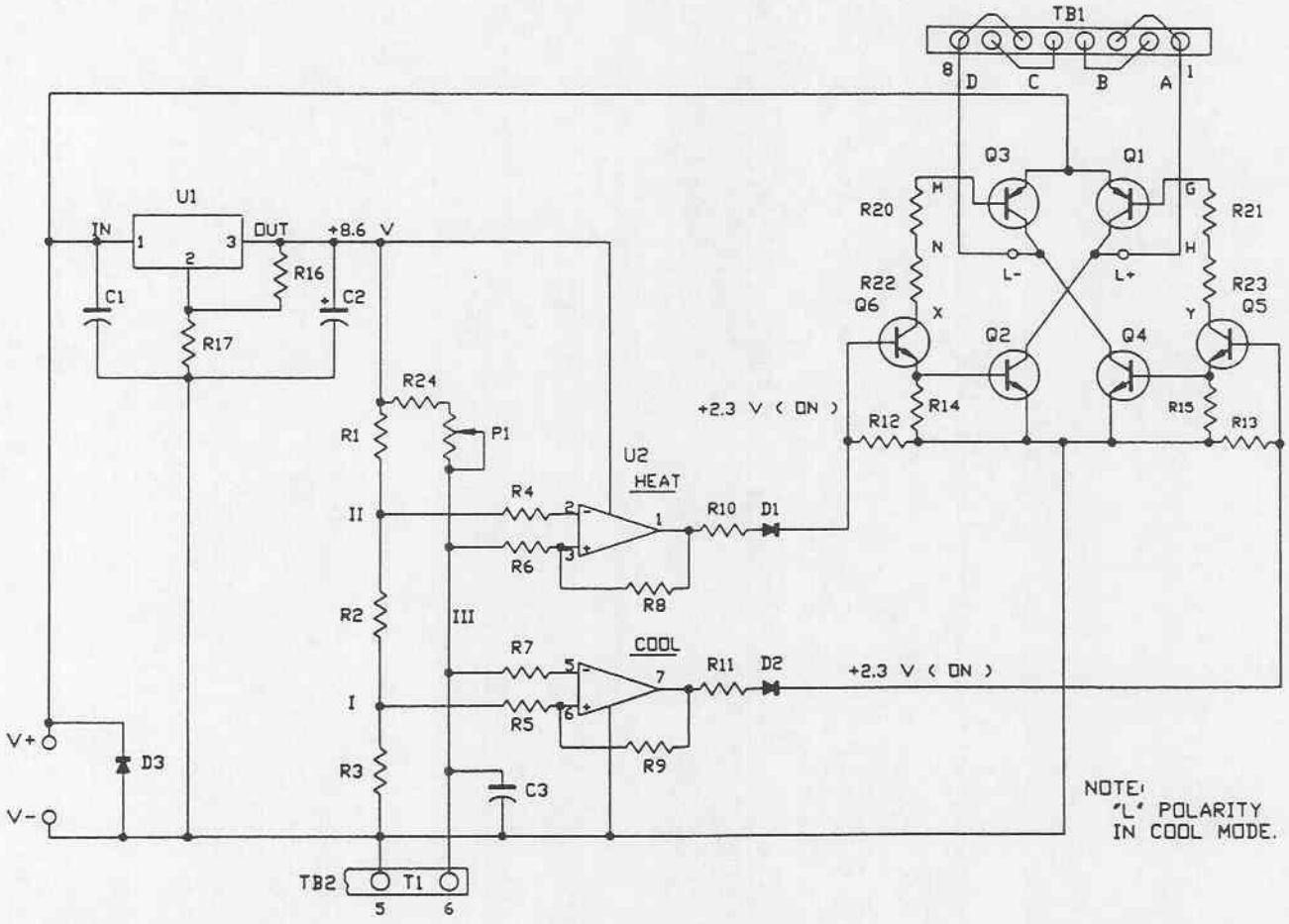
The width H of the hysteresis loop represents the on-off temperature difference in the Cool and Heat Modes. The width G represents the gap between the Cool and Heat modes. The built-in hysteresis assures that only one mode can be in operation at a time. R4, R5, R6, R7 are input resistors and determine the hysteresis. The hysteresis width is directly proportional to the values of these resistors. R8, R9 are positive feedback resistors.

R10,R11 are current limiting resistors for U2. D1, D2 establish the threshold and prevent backflow. The output of U2 is applied to the bases of Darlington drivers Q5, Q6. R20, R21, R22, R23 are current limiting resistors.

Transistors Q2, Q3 conduct in the Heat Mode. Transistors Q1, Q4 conduct in the Cool Mode.

U1 is the voltage regulator. The stabilized output voltage is supplied to the Temperature Control Section.

D3 is a reverse voltage protection diode.




D-2204

**Figure 10**
**Temperature Control Section, Schematic CAT-024**

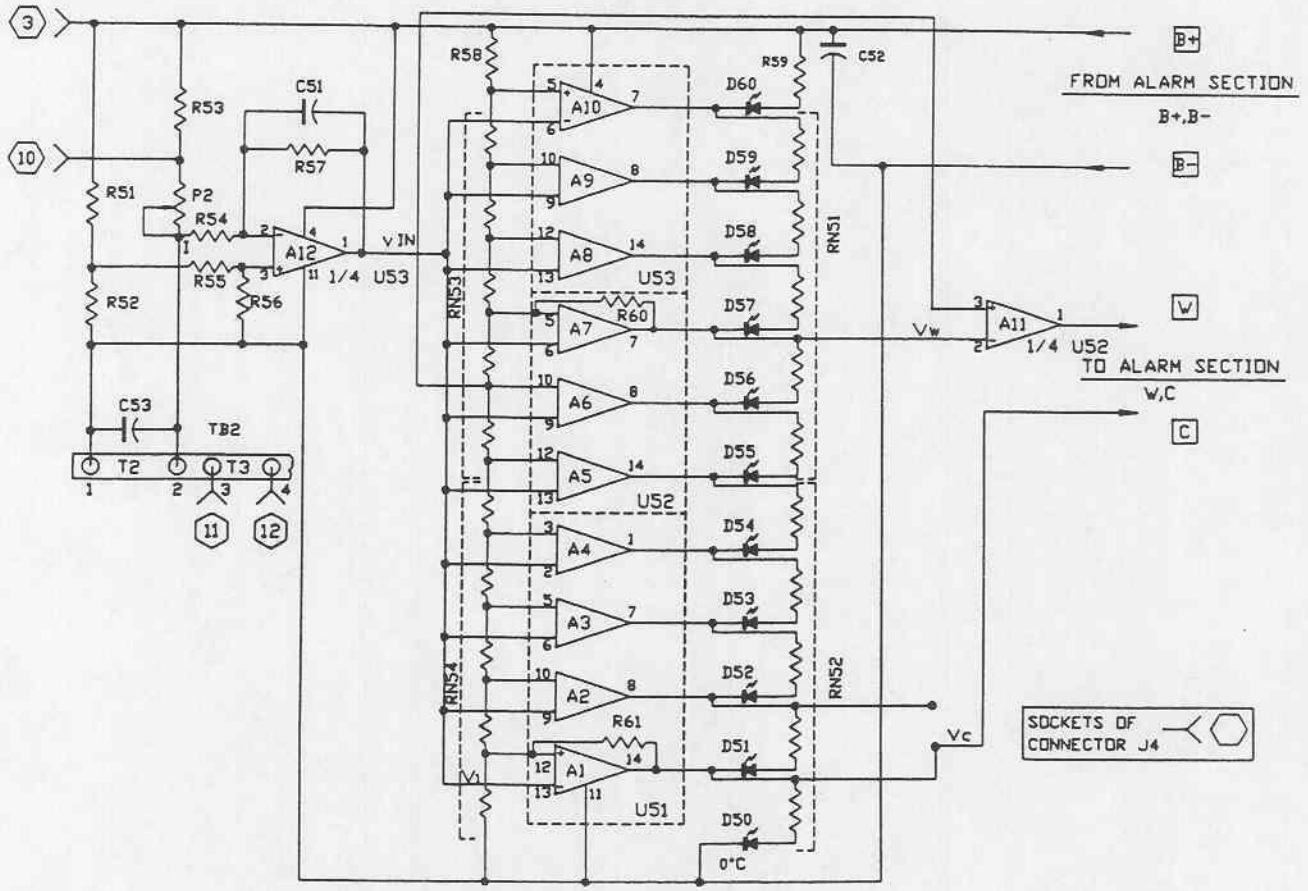
**Control Board CAT-024, Thermometer Section**

Page 25 Figure 11 Circuit Description D-2202

The thermistor T2 senses the compartment temperature. A change of the temperature at T2 causes a change of its resistance, and a corresponding voltage change at point I of the sensing bridge.

Op-amp A12 (pins 1, 2, 3) is connected as a differential amplifier whose inputs are fed from the bridge circuit consisting of R51, R52, R53 and P2 for the purpose of adjusting the calibration point. The NTC thermistor connected to points T2 forms the variable arm of the bridge. With increasing temperature, the resistance of the thermistor decreases and the voltage across it falls, the output of the op-amp A12 increases.

The output voltage of the op-amp V-IN, is applied to the display array. When the V-IN is less than the threshold voltage V1 of the first op-amp A1, all op-amp outputs are high, and the first led D50 will be on. As the V-IN increases and exceeds V1, the output of the first op-amp will conduct, thereby turning off the first led and, at the same time, allow the second led to turn on. As V-IN increases further and sequentially exceeds the individual threshold voltage of the op-amps, each led will turn on and then off when the next threshold voltage is achieved.




D-2202

**Figure 11**
**Thermometer Section, Schematic CAT-024**

**Control Board CAT-024, Alarm Section**

Page 29 Figure 12 Circuit Description D-2203

The DLA-50T incorporates an audio-visual alarm system, automatically activated when the compartment temperature falls outside the acceptable range. The alarm is powered continuously by recharging NiCad batteries. If the batteries are not inserted, the Alarm system will operate on the power supplied to the unit.

The recharging Battery Pack should be in a charged condition when the unit is put in operation. The Battery Pack should be disconnected when the DLA-50T is not in operation.

The monitoring alarm point signals are taken from the Thermometer Section (Page 25 Figure 11). When the temperature is above the acceptable range, the output of A7, W will be low. As the temperature enters the range, the output of A7 will go to high. This signal is inverted by op-amp A11. The inverted signal is applied to pin 6 of gate G1.

A temperature below the acceptable range will cause the output of A1, C to change from low to high. This signal is applied to pin 5 of gate G1.

Page 30 Figure 13-A shows the performance of the monitoring signals.

Following is the description of the Alarm Logic System (Page 30 Figure 13-B).

**Switch On**

When the circuit is switched on, the capacitor C103 is charged and creates a pulse on pin 13 of latch L1 (Page 29 Figure 12) forcing the latch to reset. Pin 10 of L1 goes to high. This high is transferred to gates G2 and G3. G3 is low on pin 2, therefore, the output will be low.

Latch L2 undergoes a similar reset, and the output at pin 10 will be high. The output of G4 at pin 4 will be low, and the alarm will be off.

**Entering Range**

When the temperature falls within the acceptable range, the output of the gate G1 on pin 4 will go to high. Pin 10 of L1 goes to low, therefore, the output of G3, with high on pin 2, will remain low. Latch L2 remains unchanged, and the alarm will remain off. At the moment of entering the range both inputs of G3 change simultaneously. The capacitor C104 suppresses the resulting narrow transient pulse at the output pin 3.

**Leaving Range**

A high will appear on the input of G1, causing a low on pin 4. Latch L1 remains unchanged. G3 will have both inputs low and a high will appear on the output at pin 3. Latch L2 is caused to change status and a low appears on output pin 10. Therefore, G4 is low on pin 6, and has pulses on pin 5. The output of G4 will be pulsed signals on pin 4, which are applied to transistor Q11, driving the audio-visual signals D5, and D6. The pulses are provided by pulse generator U12, which provides 1Hz pulses with a 50% duty cycle.

**Reset**

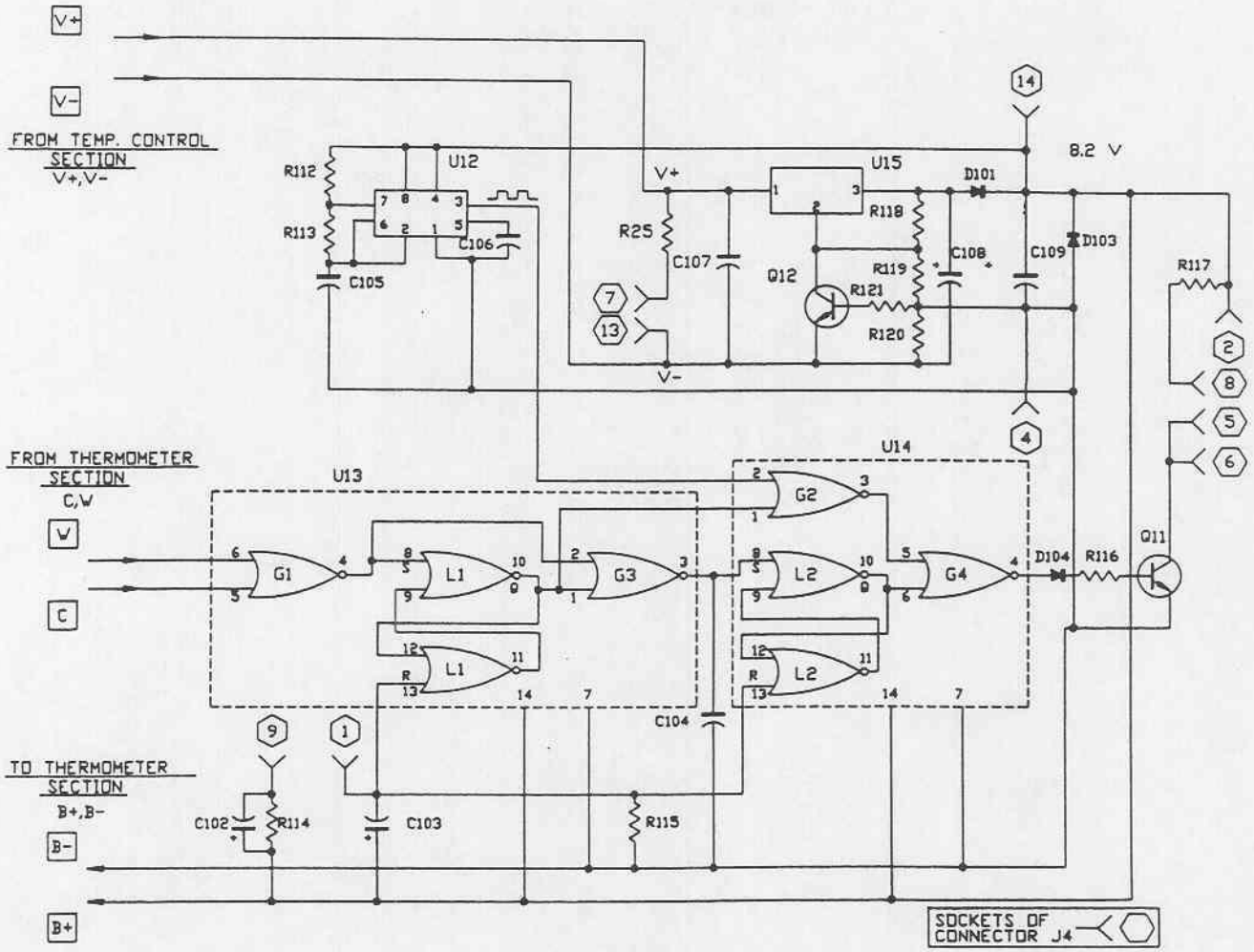
When the lever of S1 is pressed down to the RESET position, a high pulse is created by pin 13 of L1 and L2, causing the resetting of the latches. The output of L1 will stay low. If the temperature is outside the range, L1 will change, and its output will go to high. L2 will go to high on pin 10. The alarm will remain off, and the system will be in the monitoring mode.

**Test**

When the lever of S1 is pushed up to the TEST Position, R53 is shortened, simulating a condition of entering and leaving the acceptable range. The system will therefore go into, and stay in the alarm mode until the lever is pressed down to the RESET Position.

The current limited voltage regulator U15, provides 8.2VDC to the Thermometer and Alarm Sections, and supplies a charge current to the NiCad Battery Pack.

D103 is a reverse voltage protection diode. R122 protects the NiCad batteries against short circuits.




D-2203

**Figure 12**
**Alarm Section, Schematic CAT-024**

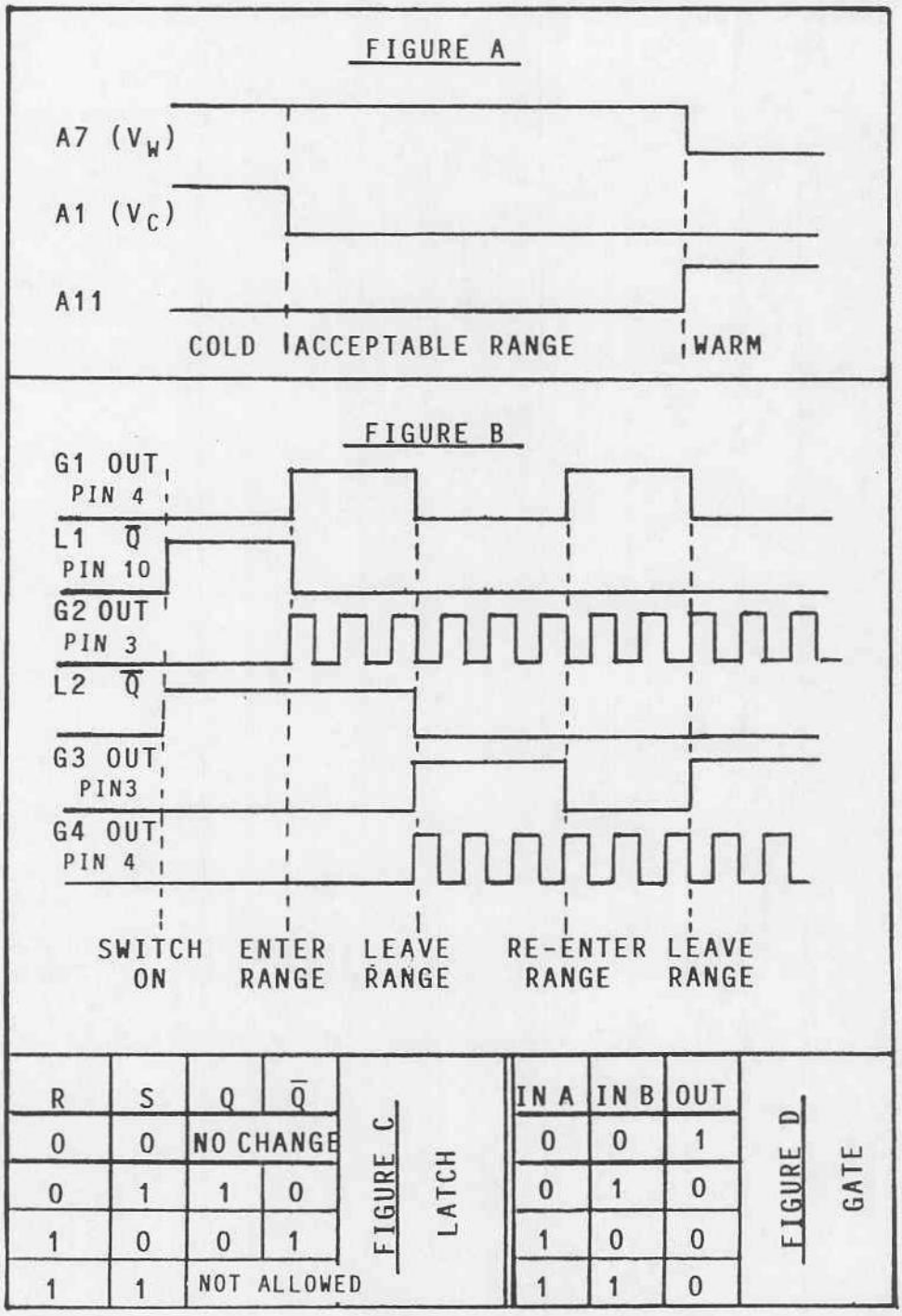



FIGURE C — LATCH

| R | S | Q | $\overline{Q}$ |
|---|---|---|---|
| 0 | 0 | NO CHANGE | |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | NOT ALLOWED | |

FIGURE D — GATE

| IN A | IN B | OUT |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

**Figure 13**
**Alarm, Logic Diagram CAT-024**

## Parts List of Control Panel

| | | |
|---|---|---|
| J3 | Connector MS-3102A-14S-05S | BOX MOUNTING RECEPTACLE |
| D4 | Diode Lite 249-7967-3332-504 | LED LAMP GREEN |
| D5 | Sonalert SC 628M | AUDIO SIGNAL |
| D6 | Diode Lite 249-7868-3331-504 | LED LAMP RED |
| CB1 | KD1-8 | CIRCUIT BREAKER 8A |
| P4 | HDM-20 M24308/4-2 | PLUG |
| S1 | Switch MS-35059-27 | SWITCH DPDT |

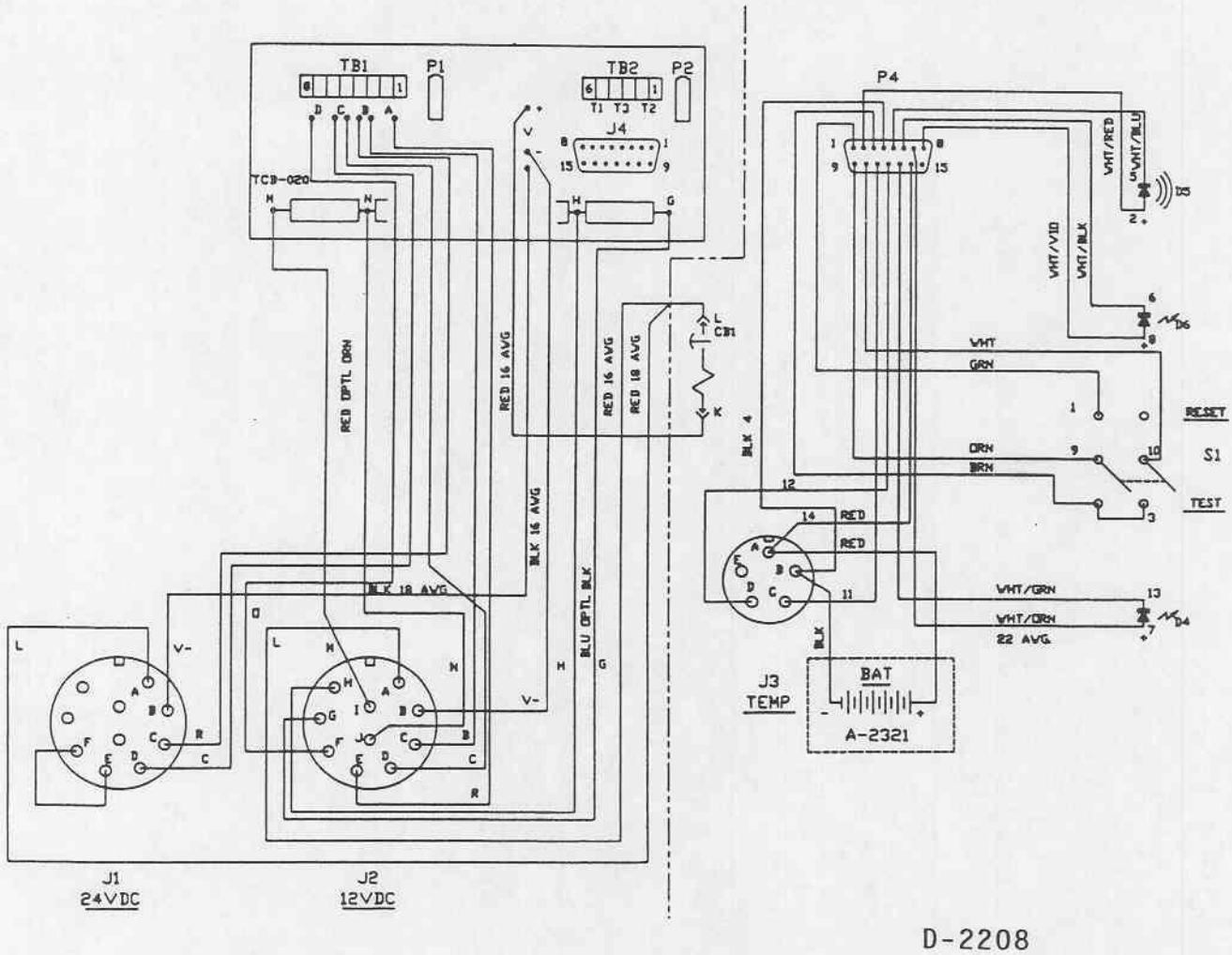



**Figure 14**
**Control Panel, Wiring Diagram**

### 1-7. Remote Thermometer/Recorder Connection

The DLA-50T incorporates a temperature sensor T3, to remotely monitor the compartment temperature. The connection to the sensor is provided through the connector J3 marked TEMP on the Control Panel. This connector also provides power for a Remote Temperature Recorder or a Remote Thermometer. (Page 10 Figure 4)

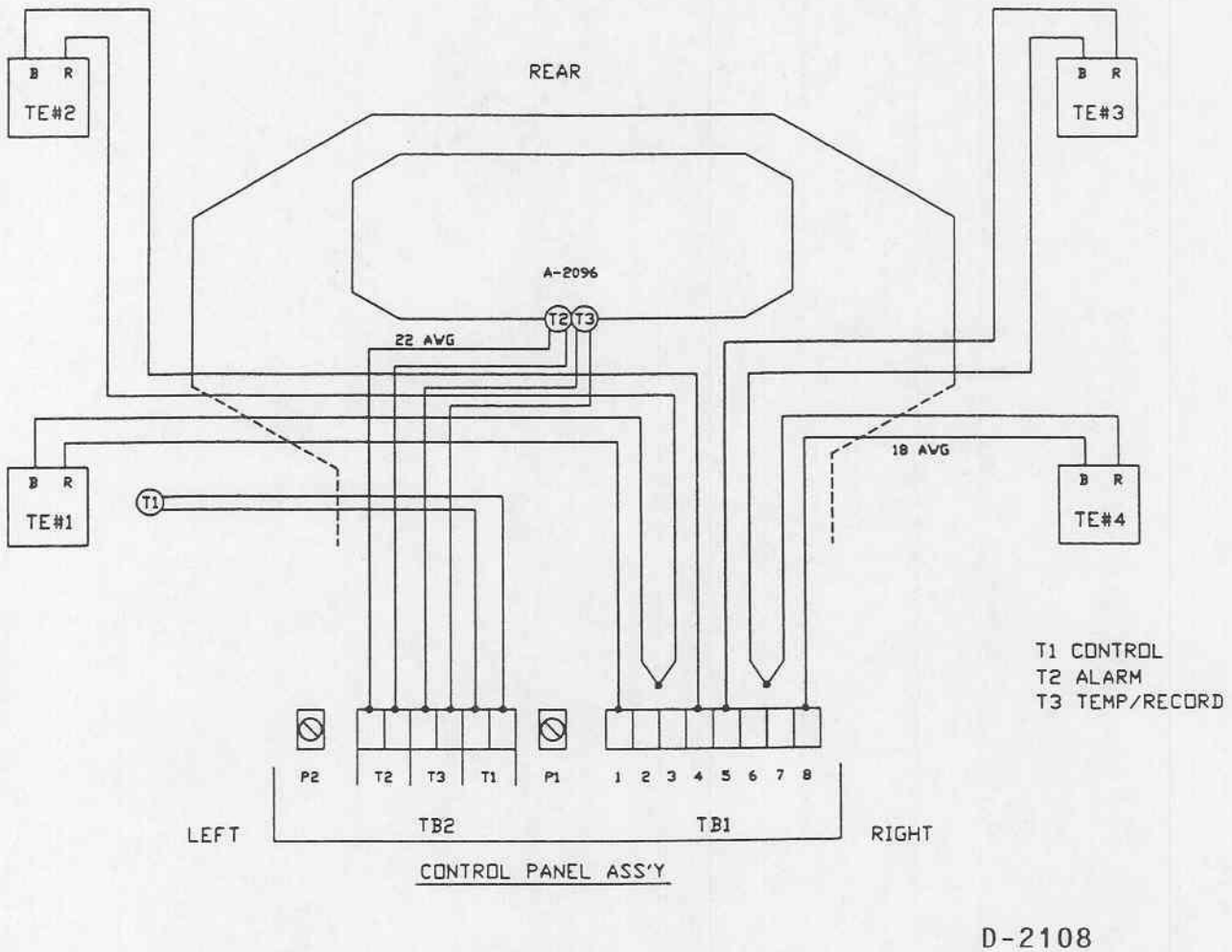



**Figure 15**
**DLA-50T - Wiring Diagram**

## Section 2
## Preventive Maintenance

### 2-1. General

Since the DLA-50T is a Solid State device and has no moving parts, it is virtually maintenance free, and there is only one preventive maintenance task to perform:

**KEEP THE UNIT CLEAN**

The inside compartment should be cleaned at the user's discretion. Ordinary soap and water are generally sufficient for cleaning the compartment. For extra soiled areas, stronger safe household detergents may be used.

To insure continued efficient cooling performance of the unit, the T.E. Assemblies, located in the four corners of the unit, See Page 8 Figure 2, should be cleaned at one year intervals. Use an air hose to blow any accumulated dirt and debris from the heat sink fins.

**Note: Cleaning materials are not provided with the unit.**

## Section 3
## Troubleshooting

**CAUTION: Troubleshooting and maintenance to be performed by qualified personnel only!**

### 3-1. General

The DLA-50T is a highly reliable instrument. However, if the DLA-50T does not operate to specifications, visually inspect the unit for obvious causes. If a visual inspection fails to reveal the source of the problem, use the troubleshooting list in this Section as an aid in locating and correcting the problem.

Before attempting to troubleshoot any malfunction of the DLA-50T, make sure the power source is correctly connected.

List of required tools for troubleshooting the DLA-50T unit

Philips head screwdriver (#2)
Flat screwdriver (medium)
Multimeter
Side cutters
Wire stripper

For AC power: Check to verify voltage selector switch of the PS-50B Power Supply is set to correct main voltage outlet 120VAC or 220VAC. (Designation on Power Supply Box: 115 or 230).

**Important Note: The PS-50B Power Supply must be connected to the 24/28VDC plug of the DLA-50T. See Page 44 Figure 18.**

For DC power: Use Power Cable A-2089, supplied with the unit, to connect the DLA-50T to your DC source (12VDC or 24/28VDC).

**Important Note: Connect Red clip (+) to Positive and Black clip (-) to Negative.**

### 3-2. Troubleshooting List

**I.** Unit does not function. Green Power indicator light is OFF, (Page 10 Fig. 4)

| | |
|---|---|
| 1. Power Circuit Breaker OFF | Push back RESET button. |
| 2. Connection faulty | Check connections and polarity. Correct if necessary. |
| 3. Power does not get to the unit | Check and correct continuity of the Power Cable. |

**II.** Unit does not function. Green Power indicator light ON.

| | |
|---|---|
| 1. Source voltage is not corresponding to the selected operating voltage. | Check and correct voltage setting of the AC selector switch of Power Supply PS-50B. |
| 2. Source is incapable to supply the required current. | Use appropriate power source. AC - 120 or 220 Volts DC - 12 or 24-28 Volts. |

**III.** Unit does not perform to specifications.

| | |
|---|---|
| 1. Faulty Module. | Check current draw. Normal 2.5-3 Amps at 24VDC. If outside limits, locate and replace faulty T.E. Assembly. (Page 36 Section 4-2.) |
| 2. Faulty Thermistor. | Check Thermistor (T1) resistance, 10K Ohms at 25° C. Replace if necessary. (Page 39 Section 4-3) |
| 3. Faulty Control Board. | Replace board. |

**IV.** Alarm System does not function.

| | |
|---|---|
| 1. Faulty Thermistor. | Check and replace Thermistor T2 (Page 40 Section 4-4) |
| 2. Faulty Control Board. | Replace board. |

V freezer is too cold/coil warm — change P1 adjust P1 to 10 turns counter clockwise to set at 36°. If you want to warm unit up turn P1 clockwise. Count your turns. 15 turns Total

VI Unit does not get cold — Change the small blocks behind fins after testing according to book

## Section 4
## Corrective Maintenance

### 4-1. General

The procedures given below, describe how to locate, remove and replace defective components of the DLA-50T.

List of tools required to replace defective components of the DLA-50T.

(1) All tools listed for trouble shooting on Page 31
(2) Rivetting Gun (Pop)
(3) Soldering Gun (60 Watts)
(4) Solder (60/40 with Rosin Core)
(5) Heat Shrink Gun (650° F)
(6) Heat Shrink Tubing (1/8", 3/16")
(7) Conductive Grease
(8) Non-conductive Silicone Adhesive
(9) Hand Drill 1/4"
(10) 1/8" Drill Bit

### 4-2. T.E. Assembly

A. Locating defective T.E. Assembly #1, #2, #3 or #4

1. Remove the 10 screws securing the Control Panel to the unit.
2. Carefully pull the Panel back by 1/2 inch, top end only, to expose the Terminal Block TB-1.
3. Disconnect wires 1 and 4 from TB-1 and connect them to a 12VDC power source, the current reading should be 2-3 Amps.
4. Repeat Step 3 with wire pair 5-8.
5. Determine the pair with the defective T.E. Assembly
6. Cut the connection between the two T.E. Assemblies behind the Control Panel. Wires 2-3 or 6-7 respectively.
7. Connect a 6VDC power source to the leads of each T.E. Assembly between 1-2; 3-4; 5-6; 7-8. The current reading should be 2-3 Amps.
8. Determine the defective T.E. Assembly.

**Note: T.E. Assembly #1 Page 38 Figure 16 (PN A-2437 contains thermistor T1)**

B. Removal of T.E. Assembly Page 8 Figure 2

1. Drill out 10 pop rivets, securing the Corner Cover to the unit. Use a 1/8 inch diameter drill. Remove Corner Cover.

2. Remove the 4 screws located inside the cooling compartment securing the defective T.E. Assembly.

3. Remove the T.E. Assembly from the unit, pulling the red and black wiring out of the insulation foam. See Page 8 Figure 2.

C. Replacement of the T.E. Assembly - SEE NOTE

1. Thoroughly wipe clean the top surface of the Module Support (Page 38 Figure 16) and the Mounting surface in the corner mounting cavity.

2. Apply a thin, uniform film of Thermal Compound to the top surface of the Module Support (2) and to the mounting surface.

3. Thread the T.E. Assembly red black lead wires through the insulating foam, into the Front Panel cavity.

4. Position the T.E. Assembly in the mounting cavity, and tighten four screws from the inside of the cooling compartment.

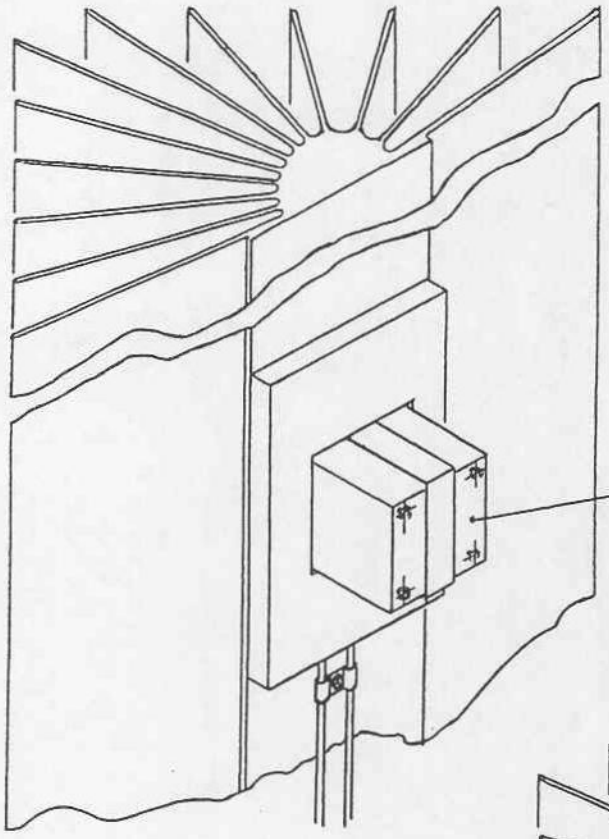
5. Splice the T.E. Assembly's leads, and apply tape over the leads.

6. Secure the Corner Cover with 1/8" D pop rivets.

7. Reconnect 1,4,5 and 8 wires to TB1.

8. Secure the Front Control Panel with 10 screws to the unit.

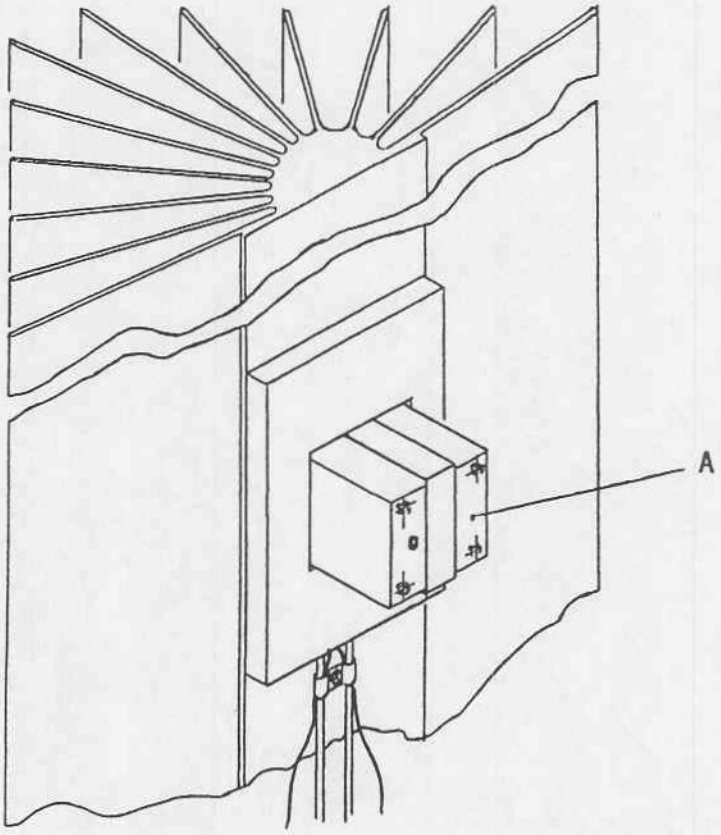
**Note: T.E. Assembly A-2437 is for Corner #1.**
**T.E. Assembly A-2436 is for Corners #2, #3 and #4.**
**See Page 38 Figure 16**



T.E. ASSEMBLY
PN A-2436
CORNER #2, 3 and 4

A

NOTE:
A- TOP SURFACE OF MODULE SUPPORT



A

T.E. ASSEMBLY
INCLUDING THERMISTOR T1
PN A-2437
CORNER #1

**Figure 16**
**T.E. Assembly**

never change heat setpoint unless unit does not keep.
If unit continues to keep cooler, change P1

**4-3. Temperature Control Thermistor T1**

A. Checking

1. Remove 10 screws securing the Control Panel to the unit.

2. Carefully pull the Panel back by 1/2 inch, to expose the Terminal Block TB-2.

3. Disconnect wires T1 from TB-2 and check resistance. Meter should read 10K ohms at 77°F (25° C).

B. Replacement of the T.E. Assembly including Thermistor T1.

1. Drill out 10 pop rivets, securing the front left Corner Cover to the unit. Use a 1/8" D drill. Remove Corner Cover. (Corner #1 Page 8 Figure 2)

2. Remove 4 screws securing the T.E. Assembly #1 from the inside of the cooling compartment.

3. Remove the T.E. Assembly from the unit.

4. Thoroughly wipe clean the top surface of the Module Support (Page 38 Figure 16) and the Mounting surface in the corner mounting cavity.

5. Apply a thin, uniform film of Thermal Compound to the top surface of the Module Support (Page 38 Figure 16) and to the mounting surface.

6. Thread the T.E. Assembly red and black lead wires with the thermistor wires through the insulating foam, into the Front Panel cavity.

7. Position the T.E. Assembly in the mounting cavity, and tighten four screws from the inside of the cooling compartment.

8. Splice the T.E. Assembly's leads, and apply tape over the leads.

9. Secure the Corner Cover with 1/8" D pop rivets.

10. Reconnect 1 and 4 wires to TB1, and the T1 wires to TB2.

11. Reset load compartment temperature with P1, (Page 18 Figure 8). To lower or raise the temperature, turn P1 clockwise or counterclockwise respectively, approx. 2 turns per 1°F (1/2°C).

12. Secure the Front Control Panel with 10 screws to the unit.

Turn P1 counter clockwise to lower temp starting at stop on P1
Clockwise to raise Temp
10 Turns counter clockwise from stop on P1 will be approximately
36°F.

### 4-4. Thermometer Thermistor T2

A. Checking

1. Remove 10 screws securing the Control Panel to the unit, (Page 8 Figure 2)

2. Carefully pull the Front Panel back by 1/2 inch, to expose the Terminal Block TB-2.

3. Disconnect wire T2 from TB-2 and check resistance. Meter should read 10K ohms at 77°F (25° C).

B. Replacement

1. Disconnect wires T3 from TB-2.

2. Remove the faulty Thermistor Probe Assembly from Housing Tube by pulling the assembly out of the tube.

3. Install new Thermistor Probe Assembly A-2223 into the Housing Tube.

4. Reconnect wires T2 and T3 to TB-2.

5. Reset Thermometer with P2. To lower temperature setting, turn 3 turns clockwise or counter clockwise per approximately 1° F.

6. Secure the Front Panel with 10 screws to the unit.

### 4-5. Remote - Thermometer/Recorder Thermistor T3

A. Checking

1. Remove 10 screws securing the Control Panel to the unit, (Page 8 Figure 2)

2. Carefully pull the Front Panel by 1/2 inch, to expose the Terminal Block TB-2.

3. Disconnect wire T3 from TB-2 and check resistance. Meter should read 3K ohms at 77° F (25° C).

B. Replacement

1. Disconnect wires T2 from TB-2.

2. Remove the faulty Thermistor Probe Assembly from the Housing Tube by pulling the assembly out of the tube.

3. Install new Thermistor Probe Assembly A-2223 into Probe Housing Tube, reconnect wires T2 and T3 to Terminal Block TB-2.

4. Secure the Front Panel with 10 screws to the unit.

## Section 5
## Power Supply PS-50B

### 5-1. General

The PS-50B is a rectifier power supply, designed specifically to provide the power to operate the DLA-50T refrigerator from a 120VAC or 220VAC, 50/60Hz in sheltered environments. The input voltage is selectable by the AC select switch of the PS-50B Power Supply, (Page 9 Figure 3).

### 5-2. Description and Specifications

The PS-50B Power Supply is well protected within a closed metal box. Two cables extend from the unit. One cable connects the main AC source to the power supply, and one cable connects the power supply to the 24/28VDC receptacle of the DLA-50T Control Panel marked 24/28VDC, (Page 10 Figure 4).

Electrical Parts List of PS-50B Power Supply PN A-2160-3

| | | |
|---|---|---|
| TR 201 | TRANSFORMER | 115/230 PRI;21.7 SEC. VDC |
| D 201 | BRIDGE RECTIFIER | 50V 25A |
| C 201 | CAPACITOR | 4900 MF, 50VDC |
| R 201 | RESISTOR | 2200 OHMS ±10%, 5W |
| CB 201 | CIRCUIT PROTECTOR KD-1 | 3 AMPS |
| S 201 | VOLTAGE SELECT SWITCH | 115/230VAC |
| P 201 | PLUG | MS-3106A-18-01S |

### 5-3. Installation

The PS-50B Power Supply is mounted on the back of the DLA-50T unit. When correctly mounted, the mounting latch will be on top. (Page 44 Figure 18)

Insert the PS-50B slotted spacer plate into the mounting bracket on the back of the DLA-50T unit and fasten the latch located on the top of the Power Supply assembly. (Page 44 Figure 18)

Both cables, the main AC Power Cable and the DC Power Cable, will come out the bottom of the Power Supply when mounted correctly.

Connect the DC Power Cable to the 24/28VDC receptacle of the DLA-50T Front Panel.

Set the AC selection switch to the correct AC voltage main, plug in to operate the unit.

NOTE: The Ps-50B is supplied with a 120VAC plug. Connect an appropriate plug for operation in other locations.

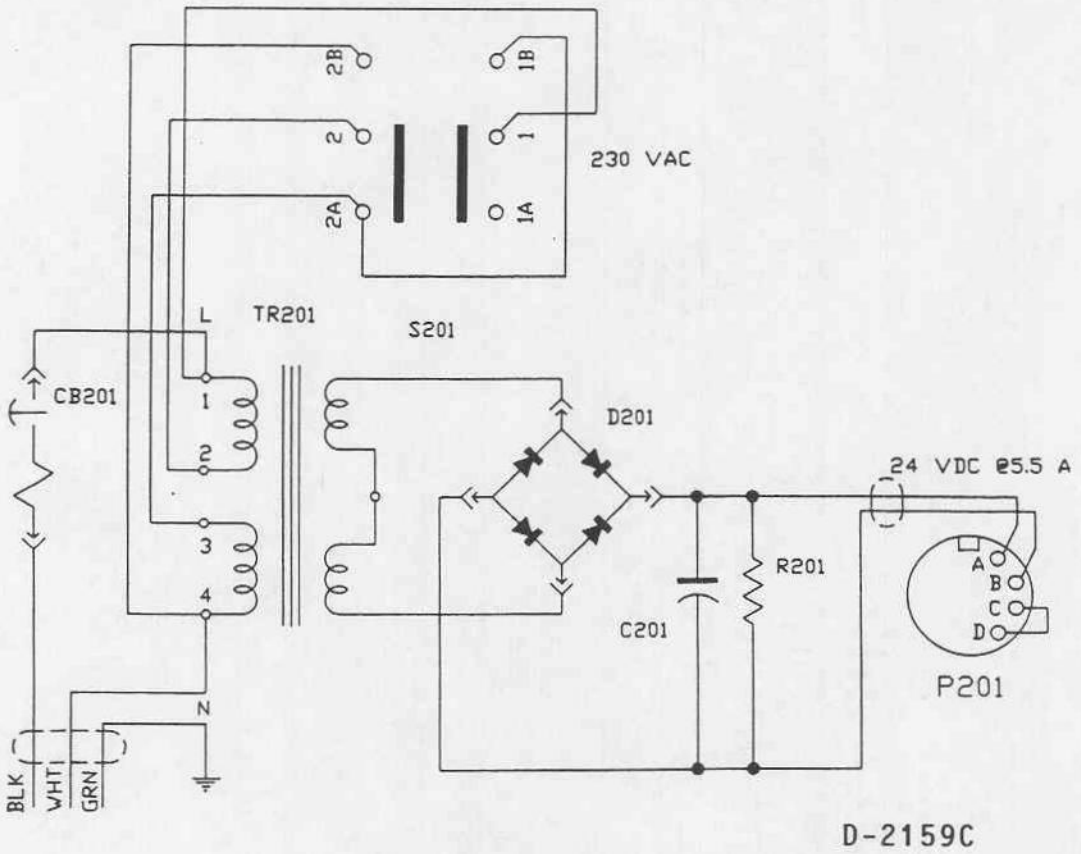



**Figure 17**
**Power Supply PS-50B, Schematic**

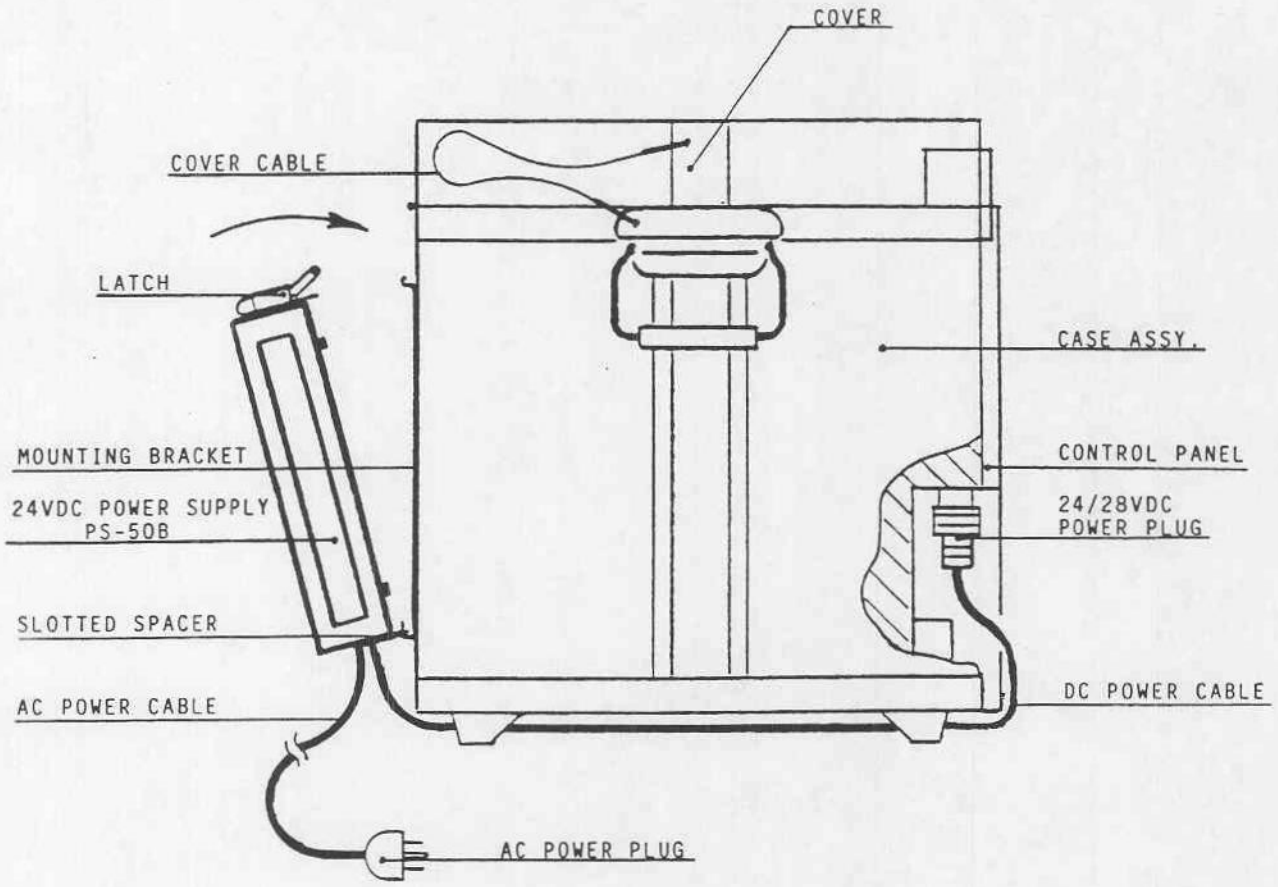



**Figure 18**
**Attaching the PS-50B**

## Section 6
## DTR-50-10 Hard Copy Recorder

### 6-1. General

The DTR-50-10 Temperature Recorder is a highly reliable instrument. The drive mechanism is tested and adjusted to close tolerances. The temperature coil is welded into place and cannot get out of adjustment.

The DTR-50-10 PN A-2224-2 will provide a hard copy of the temperature maintained within the load chamber of the DLA-50T unit.

### 6-2. Activation

To obtain a hard copy, activate the DTR-50-10 as per the instructions on the recorder. Place the activated recorder into the load chamber (together with load). A hard copy will be generated from the moment of activation. The recorder will continue to produce the hard copy for 10 days. It will record the temperature of the load chamber for as long as it is left inside the load chamber; up to 10 days.

### 6-3. Removal

The DTR-50-10 Temperature Recorder may be removed from the chamber at any time. Once removed, it will record the surrounding temperature for as long as it is left outside the load chamber. To remove the hard copy from the recorder, follow the instructions listed on the recorder.

## Section 7
## Equipment

### 7-1. General

All equipment required for the operation of the DLA-50T Thermopol Refrigerator in the United States is supplied with the unit. If, however, the unit is to be used in a geographical area in which the standard AC power is 230VAC, a local conversion plug must be used.

### 7-2. List of Supplied Equipment

| Quantity | Description | Part # |
|---|---|---|
| 1ea. | Refrigerator: DLA-50T | A-2244-2 |
| 1ea. | Rectifier Power Supply: PS-50B | A-2160-3 |
| 1ea. | Wire Basket: WB-30B | A-2428 |
| 1ea. | Power Cable: PC-30B | A-2089 |
| 1ea. | Temperature Recorder: DTR-50-10 | A-2224-3 |
| 2ea. | Maintenance Manual | DLA-50T-MM1 |
| 2ea. | Operational Manual | DLA-50T-OP1 |

### 7-3. List of Required Equipment - Not Supplied

**NONE**

## Section 8
## Installation

### 8-1. General

The following information should be used to assist in the prompt set-up of the DLA-50T Blood and Vaccine Refrigerator. These directions for unpacking and installation will considerably ease initial set up, and avoid unnecessary mistakes.

### 8-2. Proper Location of Equipment

The DLA-50T is designed to operate at ambient temperatures of between -13° F (-25° C) and 120° F (49° C) as per Climatic Criteria AR 70-38; QSTAG 360.

### 8-3. Assembly Interconnections

The Battery Pack PN A-2321 should be mounted directly to the Control Panel. The two slotted screws should be securely fastened. When in storage, loosen the two slotted screws to disconnect the Battery Pack. (Page 8 Figure 2)

For AC operation, the PS-50B Rectifier Power Supply PN A-2160-3 can be mounted on the rear mounting bracket of the DLA-50T Blood and Vaccine Refrigerator, (Page 44 Figure 18). It should then be connected to the 24/28VDC receptacle, located and marked on the Control Panel. The AC cable should be plugged into the correct AC main. (Page 9 Figure 3)

For DC operation, use the Power Cable A-2089, supplied with the DLA-50T. Connect the cable between the DC power source and the corresponding connector located and marked on the Front Panel. (Page 8 Figure 2)

**Note: When properly connected, the Green power indicator light should be on. No switching is needed.**

## Section 9
## Operation

### 9-1. Initial Adjustments

The DLA-50T is factory set for normal operation. No initial adjustments are necessary.

The PS-50B Power Supply is factory set to 110VAC. If used at a 230VAC location, the Power Supply must be set to local voltages. To adjust, use a flat screwdriver and move the slide switch to the 230VAC position, as indicated on the PS-50B Power Supply.

NOTE: Connect an appropriate AC power plug for operation in other than 110VAC locations.

### 9-2. Starting, Operating and Stopping the Equipment

To start the operation of the DLA-50T, the unit must be connected into an appropriate power source. Once the unit has been properly connected, the green power indicator light will be on. No switching or adjusting is necessary.

The connector receptacles, switches and indicators of the unit are all located on the Control Panel and are marked with their functions. (Page 10 Figure 4)

**Steps for starting the unit in operation:**

1. Source Voltage Determination

Ascertain available power source voltage: 110VAC, 220VAC, 12VDC or 24-28VDC.

2. Connection to Unit

Connect the DLA-50T in accordance with the source voltage:

| Source | Connection | Receptacle |
|---|---|---|
| 12VDC | Power Cable PN A-2089 | J2 - 12VDC |
| 24/28VDC | Power Cable PN A-2089 | J1 - 24VDC |
| 110VAC or 220VAC | Power Supply Plug | J1 - 24VDC |

3. Installation of Alarm Battery Pack

Install a charged Battery Pack in the Front Panel recess, (See Page 8 Figure 2). The indicator of the Compartment Thermometer will light. If the battery voltage is low, no light will appear on the Thermometer. The Battery Pack will charge automatically when power is provided to the unit. To ascertain the performance of the Battery Pack, disconnect the DLA-50T after approximately 15 minutes and observe the light on the Thermometer, indicating proper operation.

**Note: The Alarm and Thermometer will operate with or without the Battery Pack when power is provided to the unit.**

4. Alarm/Battery System Test

Push the lever of the Alarm Switch, located on the Control Panel, up to the Test position. The temperature indicators will light sequentially and momentarily. The Red Alarm Light will blink and the sound signal will beep. Push the lever of the Alarm Switch down to the Reset position. The Alarm Mode will be off.

5. Connection to DC voltage

For 12VDC or 24-28VDC, the red positive clip of the D.C. Power Cable must be connected to the positive (+) contact of the source, and the black negative clip, to the negative (-) contact of the source.

6. Connection to AC Voltage

For AC operation, the PS-50B Power Supply is plugged into an AC main. Check and set correct voltage of the Power Supply before connecting the DLA-50T.

When correctly connected and powered, the green power indicator on the Control Panel will light, and the DLA-50T will be in operation. The compartment temperature will be indicated by the color coded, solid state thermometer changing from red to yellow to green in the normal range. The DC plug of the PS-50B Power Supply must be connected to the 24/28VDC receptacle of the DLA-50T Front Panel, (Page 44 Figure 18).

The receptacle in the Front Panel marked TEMP is used to connect a Remote Temperature Recorder or a Remote Thermometer, (Page 10 Figure 4).

**Steps for normal operation**

Operation is maintenance-free as long as the unit is properly connected to a correct power source, it will maintain a compartment temperature of 35.6° F (2° C) to 42.8° F (6° C).

**Steps for stopping operation**

Stopping the equipment requires unplugging it from its power source. It is advisable to remove the Battery Pack while unit is not in operation.

If the unit is to be idle for an extended period of time, it is advisable to thoroughly wash the compartment with soap and water prior to storage.

### 9-3. Storage

The DLA-50T may be stored in a normally vented storage facility. Storage envronmental temperature of -25°F (-32°C) to 120°F (49°C) is acceptable.

Short term: Clean the unit's load compartment with a mild detergent. Store Power Cable, Power Supply, Battery Pack, and Recorder inside the clean load compartment.

Long term: Same as above. In addition, clean outside of unit by blowing an air stream over the unit. Blow dust and dirt from the 4 Heat Sinks located in the 4 corners of the unit. (Page 6 Figure 2). Place in a carton container or cover with a plastic bag. Place in a sheltered.

## Section 10
## List of Replacement Parts

### 10-1. General

The following parts list is in tabular form, with four columns: Part Number, Description, Quantity and Location Reference.

a. Part Number: the Thermopol Inc. part number.

b. Description: a brief functional description of the part.

c. Quantity: the number required for 1 complete subassembly.

d. Location: page number and figure in this manual, whenever applicable.

### 10-2. List

| Part Number | Description | Quantity | Location Ref. |
|---|---|---|---|
| **A-2219** | **Case Assembly** | **1** | **Page 8 Fig 2** |
| P-2261 | Rim | 1 | Page 8 Fig 2 |
| P-2239 | Hinge | 1 | Page 8 Fig 3 |
| C-2091 | Latch (Catch) | 2 | Page 8 Fig 2 |
| P-2264 | Handle | 2 | Page 9 Fig 3 |
| P-2258 | Cover, Corner | 4 | Page 8 Fig 2 |
| **A-2435** | **Cover Door Assembly** | **1** | **Page 9 Fig 3** |
| P-2063 | Gasket, Cover | 1 | Page 8 Fig 2 |
| P-2257 | Bracket, Strike | 1 | Page 8 Fig 2 |
| C-2091-1 | Latch | 2 | Page 8 Fig 2 |
| P-2097 | Door Cable | 1 | Page 8 Fig 2 |
| P-2239 | Hinge | 1 | Page 9 Fig 3 |
| **A-2436** | **T.E. Assembly** | **1** | **Page 8 Fig 2** |
| **A-2437** | **T.E./Sensor Assembly**<br>NOTE: In Corner #1 only! | **1** | **Page 8 Fig 2** |

| Part Number | Description | Quantity | Location Ref |
|---|---|---|---|
| **A-2209-2** | **Control Panel Assembly** | **1** | **Page 8 Fig 2** |
| A-2205 | Control Board Assy | 1 | Page 17 Fig 7 |
| A-2211 | Panel, Front Assy | 1 | Page 8 Fig 2 |
| C-4110-08 | Circuit Protector KD8 | 1 | Page 10 Fig 4 |
| C-4105 | Audio Alarm Signal | 1 | Page 10 Fig 4 |
| C-4104 | Alarm Test/Reset Switch | 1 | Page 10 Fig 4 |
| C-4106-1 | Visual Alarm Signal | 1 | Page 10 Fig 4 |
| C-4106-2 | Power Indicator | 1 | Page 10 Fig 4 |
| P-2214 | Interlock | 1 | Page 10 Fig 4 |
| **A-2160-3** | **PS-50B Power Supply** | **1** | **Page 43 Fig 17** |
| C-2312 | Transformer | 1 | Page 43 Fig 17 |
| C-4107 | Rectifier | 1 | Page 43 Fig 17 |
| C-4108 | Voltage Select Switch | 1 | Page 43 Fig 17 |
| C-4109 | Capacitor | 1 | Page 43 Fig 17 |
| C-4110-03 | Circuit Breaker KDI-3 | 1 | Page 43 Fig 17 |
| A-2439 | 24V Power Cable Assembly | 1 | Page 43 Fig 17 |
| A-2440 | Line Power Cable | 1 | Page 43 Fig 17 |
| C-2091-1 | Latch | 1 | Page 44 Fig 18 |
| **A-2321** | **BP-50 Battery Pack** | **1** | **Page 44 Fig 18** |
| **A-2089** | **Power Cable** | **1** | **Page 8 Fig 2** |
| **A-2420** | **WB-30B Wire Basket** | **1** | **Page 8 Fig 2** |
| **A-2223-2** | **Thermistor Probe Assy** | **1** | **Page 8 Fig 2** |
| **A-2224-** 2 | **DTR-50-10 Hard Copy Recorder** | **1** | |
| **DLA-50T-MM1** | **Maintenance Manual** | **2** | |
| **DLA-50T-OP1** | **Operational Manual** | **2** | |

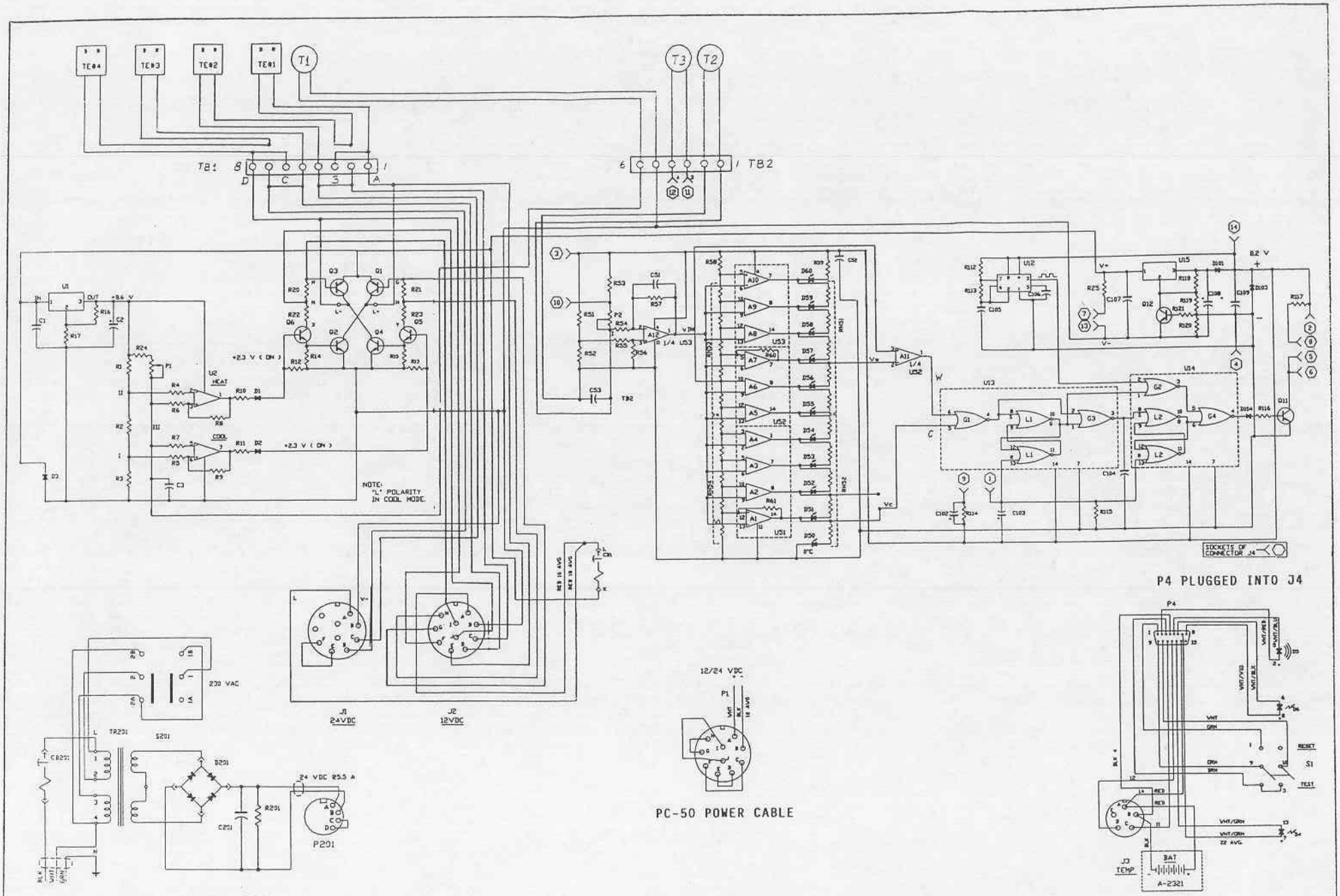



FIGURE 19 DLA-50T SYSTEM SCHEMATIC

# THERMOPOL INC. THE DESERT STORM PATRIOT

## BIOLOGICAL,BLOOD,VACCINE AND DRUG STORAGE AND TRANSPORTATION REFRIGERATOR

*Dear Customer:*

*Extensive developmental work and military exposure led to the design of our M-30BT and M-50BT Solid State transportation and storage units.*

*Twenty years of military use proved that refrigerators containing no moving parts are both environmentally safe and highly reliable; thus, the perfect alternative to ice coolers.*

*Our thermo-electric refrigerators have been used for a variety of applications, including the transportation of biologicals, organs, blood, vaccine and drugs.*

*Since 1971, our units have been extensively tested in the most adverse environmental conditions, and are referred to as "The Golden Standard" for blood transportation and storage.*

*DESERT STORM'S heroic operation further established our units as second to none. No degenerative effects were reported and no returns for repair were experienced.*

*Solid State refrigeration is our only product line. State of the art technology is our only future. You can rest assured that our products will continue to lead the market in thermo-electric innovations and performance.*

*Sincerely,*

*S. Beitner*
*President*

N.S.N. No. 4110-01-287-7111
NATO CODE No. 4110-99-770-7126 CFC
FDA No. BK-900017

| MODEL | M-30BT | M-50BT |
|---|---|---|
| DIMENSIONS | 46H X 66W X 44D CM. 18" X 26" X 17" | 58H X 66W X 56D CM. 23" X 26" X 22" |
| CAPACITY | 28 LITER / 1 CU. FT. 30 X 450 ml BAGS | 57 LITER / 2 CU. FT. 70 X 450 ml BAGS |
| WEIGHT | 20 KG / 45 LB | 35 KG / 77 LB |
| POWER AT S.T.P. | 50 WATTS | 100 WATTS |

THERMOPOL INC. is the original manufacturer of NO MOVING PARTS, thermo-electric refrigerators used by the military for storage and transportation of blood, biologicals, vaccine and drugs.

This latest development is the result of over twenty years of military usage including exposure to hot and freezing climatic environments - Desert Storm included.

- Designated M-30BT and M-50BT the units provide the required optimal inside temperature of 4°C (40°F) ± 1°C (2°F) at ambient temperatures of -33°C (-27°F) to 49°C (120°F), as per MIL. STD. 210B and climatic criteria AR 70-38 ; QSTAG 360.

- The units meet storage requirements of -33°C (-27°F) to 71°C (160°F) as per climatic criteria AR 70-38 ; QSTAG 360.

- The units operate on 12VDC or 24/28VDC and can be plugged into a 115VAC or 230VAC mains, through a detachable rectifier power supply (PS-50B).

- The units incorporate a built-in audio visual alarm system automatically activated when the inside temperature falls outside the acceptable 2°C (36°F) to 6°C (43°F) range. The independent alarm system is powered continuously by a recharging NiCad battery.

- The units incorporate a Solid State, color coded thermometer indicating the storage compartment temperature, between 0°C (32°F) to 10°C (50°F).

- The units incorporate a connector for a recording thermometer to read the storage compartment temperature, between -10°C (14°F) to 20°C (68°F).

- The units meet MIL. STD. 461 (electromagnetic emission and susceptibility requirements) E.M.I.

- The units exceed the Best Operational Capability value (BOC) requirement.

As a result of extensive military field experience and careful consideration of human engineering objectives, many vital features were incorporated.

» A circuit breaker fully protects the unit and eliminates the need to carry spare fuses in combat conditions or emergencies.

» Separate connectors are provided for dual voltage requirements - 12VDC and 24/28VDC, to eliminate accidental voltage switch over.

» All panel connectors are recessed, for protection against breakage or mishandling.

» Retractable spring loaded carrying handles, to eliminate rattle noises during transportation.

» Stacking features to allow for self-alignment.

» Patented thermo-electric module assemblies for increased efficiency and extended reliability.

» All materials, workmanship and processes comply with pertinent military specifications.

» Easy loading and unloading of unit and its contents.

» Auto reverse current maintains preset compartment temperature in freezing ambient conditions.

PATENT NO. 4,622,822

**FOR INFORMATION, CONTACT:**

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